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SUGAR CANE

AND ITS CULTURE

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AND ITS CULTURE

BY

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PREFACE

This book has been written as the result of over twenty years of work and observation in the cane fields of Cuba and Porto Rico. It is hoped that it may prove useful both to the practical field man and to the sugar-cane technologist. The former may be assured that all of the practices suggested have been thoroughly tested in the field, most of them on an extensive scale, and that they are perfectly practical and workable. The technical man will be much more likely to note omissions, and possibly even erroneous statements, since the book has been written far from reference libraries and laboratories. In only too many cases it has been necessary to glean the opinions and results of other workers at second hand in the columns of the contemporary sugar reviews and periodicals. Frankly, the atmosphere of the book is that of the cane field rather than that of the research laboratory. This may or may not be an advantage according to the point of view of the reader. At least the work will serve to bring together in one volume a fairly comprehensive view of the sugar-cane situation in all parts of the world. Its object will be attained if it proves useful to even a small part of the isolated and widely scattered workers in the cane-sugar industry.

Herradura, Cuba, Jan. 12, 1928.

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Part One

SUGAR CANE

SUGAR CANE AND ITS CULTURE

CHAPTER I

HISTORICAL

Sugar has been made from sugar cane in India and Southern China since the earliest times. The industry was an established one in the Philippines, in Java, and in the other islands of the East Indies at the time of their discovery by Europeans. Captain Cook enumerates sugar cane among the products of the Hawaiian Islands. It should be noted that the canes of India and China are quite distinct from those of the Pacific Islands. The botanical relationships of the two groups are not yet clearly understood.

The Arabs carried sugar cane from India to the shores of the Mediterranean in the early years of the Christian era. According to Deerr, there was a flourishing industry in Southern Spain earlier than 1000 B.C. It reached Madeira in 1420 and a little later was carried to the Azores, the Canaries, and Portuguese West Africa. Competition with these more tropical countries and political disturbances due to the capture of Constantinople by the Turks caused its practical disappearance from Southern Europe during the latter part of the fifteenth century. On his second voyage, in 1493, Columbus took sugar cane to Hispaniola, or, as it is now called, Santo Domingo. It is supposed that this first shipment was lost, but cane is known to have been growing there in 1507 and the first sugar was made in 1509. From this island as a center of distribution, cane soon reached Cuba, Porto Rico, and the other West Indies. It was carried to Mexico in 1520. The first sugar mill was established in Porto Rico in 1524. Cane reached Brazil in 1552, and Peru in 1533, but it does not seem to have been established in Argentine before 1620. The Jesuit Fathers introduced it in Louisiana in 1751.

All of these early movements of sugar cane, both in Europe and in the Western Hemisphere, had to do with one single variety only. This was a short-jointed, medium-slender, greenish cane of poor

tonnage, but with sweet juice and soft tissue that made it easy to mill and pleasant to chew. This last fact has led to its preservation to the present time, since in some localities it is still planted in a small way for eating purposes and for sale in the towns, though it has long since ceased to be a factor in sugar production. It seems to be related to the Indian rather than to the South Sea Island canes, thus confirming the tradition of its origin. With so many kinds of canes long cultivated in India, it seems strange that this early Arabian importation was concerned with only one. This may be due to the fact that it was a favorite for eating, since cane has often been grown for this purpose rather than for sugar making. It is altogether probable that it is still grown in India, but it is a sad commentary on the neglect that has long followed everything connected with the agriculture of sugar cane that its identity and true name are still unknown.[1] It needed no special name for the first three centuries of its growth in America, since it was the only sugar cane known. When other varieties were finally introduced it came to be known as native cane, *caña del pais, caña de la tierra,* or more often as "Creole cane." In Louisiana and Argentina this name is also given to the striped and red Cheribon canes.[2]

In considering the history of the sugar-cane industry we must now leave the West Indies and turn our attention to the little island of Mauritius in the Indian Ocean off the East Coast of Africa. The industry is said to have been founded here by De la Bourdannais in 1737. What varieties he planted we do not know, but it is not probable that he had the Creole, the history of which we have been discussing. We also know on the authority of Watts "Dictionary of the Economic Products of India" that a Dr. Thompson, at that time government agent in Madagascar, about 1813 sent thirteen varieties of cane from that island to the botanical gardens in Mauritius. He also stated that when the French were driven out of Madagascar in 1657 they took the canes of Madagascar with them to the island of Bourbon (now Réunion). From Bourbon they moved to Mauritius in 1715, and Dr. Thompson thought that this Madagascar cane was the original basis of the industry in both of these islands. One of the varieties which he sent to Mauritius he found to be identical with the cane originally cultivated there. This would indicate that these original canes were probably of South Pacific rather than of Indian origin. The Malays have been bold navigators for centuries

[1] Since the above was written, this cane has been positively identified as the Puri of India by Mr. Noel Deerr. (See Int. Sug. Jour., Jan., 1928, p. 11.)

[2] In the opinion of Dr. Jeswiet these canes belong to the Preanger and not to the Cheribon series.

and they are accustomed to carry sugar cane on their voyages as part of the provisions for the crew. This accounts for the wide dispersal of many of the South Pacific canes, long before the records of sugar-cane literature began. Whatever this early cane of Mauritius may have been, it was completely replaced during the later years of the eighteenth century by better and more productive kinds.

Bougainville, who sailed around the world in 1766–68, is said to have touched at the island of Otaheite and to have landed canes from that island in Mauritius. In 1782 Cossigny imported to Mauritius a number of canes directly from Java. We do not know with certainty what they were, but there is reason to suppose that this importation included one or more of the Cheribon or Preanger canes which are to this day furnishing the greater part of the world's cane sugar. At first, however, the Otaheite cane was greatly preferred. It became very generally planted, quickly replacing the earlier kinds. On virgin lands the tonnage produced was enormous, and it was a cane easily worked by the crude mills and primitive manufacturing processes of those times.

Meanwhile, soon after Cossigny's importation, the French Government took all of these kinds to its West Indian Colonies and to Cayenne. What was probably the Otaheite cane of this importation became known as Bourbon, after the island of that name near Mauritius. Here again it quickly became a great favorite and soon spread to the neighboring British islands.

At about the same time, 1791, Captain Bligh made a direct importation of cane varieties from Otaheite to Jamaica. Among them was one, as shown by Tussac's beautiful colored drawing in his "Flora Antillarum," which was clearly the cane later so extensively planted in all parts of the sugar-producing world under the names of Otaheite, Bourbon, Caña Blanca, and later in Hawaii as Lahaina. It quickly became a universal favorite and its extensive planting really marked the beginnings of the modern sugar industry. Whether or not this cane and the one brought by the French Government from Mauritius to the West Indies were really the same is a question that has led to endless discussion. Presumably they were the same. At least this is the opinion usually expressed in the literature, but a doubt still remains since a number of other green or yellow canes are commonly found admixed with Otaheite in the few regions where this one-time favorite cane is still found.

From this time on, the history of the cane-sugar industry inevitably becomes more and more a history of the introduction and distribution of cane varieties, such introductions usually being caused

by the outbreak of epidemics that have seriously threatened the local industry.

The gradual improvements in manufacturing methods and the evolution of the great, modern, electrically driven central, from the little shack with its open kettles and feeble animal- or wind-driven rollers of a hundred years ago, do not concern us here. Like the hard-worked field manager of the modern plantation, with his thousands of acres to plant, cultivate, and harvest, we are ready to say good-bye to the cane when we see it dumped in the carrier and disappearing in the voracious jaws of the crushers. Even improvements in cultivation methods, great as they have been in some instances, must be discussed locally rather than generally, for, strange as it may seem, a good half of the cane ground in these modern factories is produced by the same crude agricultural methods that were in vogue at the time of the introduction of the Otaheite cane to Mauritius and the West Indies.

For a number of decades after its introduction, this Otaheite cane continued to grow vigorously and yield abundantly, producing great riches for the fortunate sugar planters. In the West Indies particularly, this was the period of greatest prosperity. The Otaheite cane still grows vigorously and yields abundantly when planted on moist but well-drained and rich virgin lands. However, it was found after the first richness of the soil had been exhausted by continued plantings, or when plantings had been made on poorly adapted soils, that the production was rapidly decreasing. Much began to be written about the running out of the Otaheite. It was said to be degenerating. Finally, diseases began to appear; in one country after another, epidemics occurred which devastated the cane fields, often with such suddenness as to cause a serious catastrophe to the industry. The earliest case of the kind to be recorded occurred in Mauritius and Réunion, about 1840. The exact nature of this outbreak has not been determined, but it was probably root disease, to which the Otaheite is so susceptible as lands become old and compacted. The complete and rather sudden failure of this favorite kind led to the searching of all parts of the sugar-cane-growing world for other kinds with greater resistance to the prevailing trouble with which to replace it. Canes were brought from Java and other regions of the East Indies, from the West Indies, from Egypt, and from Brazil. The large collection of varieties thus brought together made Mauritius a center of distribution from which other cane-growing countries have drawn, as in one after another the favorite Otaheite went down before the various enemies to which it is so susceptible.

Brazil seems to have been the next country to suffer from a cane epidemic. About 1860 (the exact date has not been determined), an outbreak of gum disease almost completely destroyed the Otaheite, or, as it was there called, the Cayania cane. It is evident that many varieties were brought to Brazil in the effort to reestablish the sugar industry, since large numbers are known to have existed at the Rio Janeiro Botanical Gardens and at the Experiment Station at Campinas. So far it has not been possible to trace the history of these introductions. Collections from Rio and Campinas were sent to Argentina, to northern Brazil, and to the West Indies; but most of the varieties seem to have been renamed, since the names applied to these canes from Brazil are different from those used in Mauritius and other countries, and this makes their identification difficult. For instance, the red cane which came to replace the Cayania or Otaheite in general cultivation on account of its resistance to gum disease, and which is properly known as Cavengirie, is called Louzier in Brazil, although that name is one of the recognized synonyms of Otaheite.

From Brazil the gum disease seems to have been carried to Mauritius in a shipment of cane varieties known to have been made in 1869. Had the industry there still been based entirely on the Otaheite this would have caused another catastrophe, but that very susceptible kind had already gone out of cultivation and the gum disease did comparatively little damage to the kinds that had replaced it. From here the disease was later carried to Australia where it has from time to time caused serious losses. It was here that it was first fully described and seriously studied and so it has come to be called the Australian gum disease. Recently it was detected in Porto Rico. It is capable of causing very serious losses, since it greatly reduces yields, causes difficulties in the manufacture, and soon kills the infected stools. Luckily, a considerable number of the better varieties are quite resistant or even immune, so that this disease is no longer feared as formerly (see chapter on Pests and Diseases).

In 1872 a disease appeared in the Otaheite cane on the east coast of Porto Rico. It so happens that the outbreak was first noted on the farm where the Federal Experiment Station is now located near Mayaguez. From here it soon extended until the entire western half of the island was involved. In the infected fields the cane was short and stunted and soon died out entirely. Government and local commissions were appointed to study the disease. The seriousness of the situation can be appreciated from their reports which were carefully gathered together and published by Dr. Augustin Stahl of Bayamón,

but the nature of the disease was not determined and to this day the cause of the outbreak is not known with certainty. It was probably another severe outbreak of root disease, though there are reasons for thinking that it may have been complicated with Matz's vascular disease (see chapter on Pests and Diseases). In any event, it was soon observed that stools of Crystalina and Rayada, which were everywhere occasionally scattered among the Otaheite, were but little affected, and the industry was restored by selecting and planting these hardier kinds.

In Cuba and the British West Indian Islands the change was not so sudden and spectacular as in Porto Rico, but it was equally complete. As the soils became older and more compacted, the once universally planted Otaheite, Bourbon, or Caña Blanca was gradually completely replaced by the Cheribon or, as we must now say, the Preanger canes, whose hardier root system was better adapted to these changed soil conditions. The light and the striped kinds were both used, the one being more popular in some localities, while the other was preferred in others. The dark variant never seems to have been extensively planted in the West Indies although popular in Louisiana.

These repeated and often sudden failures of the Otaheite illustrate forcibly the unwisdom of basing the entire cane industry of a country on any one variety. For a hundred years, in all parts of the world, this was the only kind considered worth planting. Had it not been for rank carelessness in allowing other kinds to grow as admixtures among the Otaheite, the catastrophe would have been even more tragic and complete. As it was, the despised Preanger canes were everywhere present and were used to make replacements.

The scene now shifts to Java. About 1880 a serious epidemic, which came to be known as the sereh disease, broke out in the cane fields. This time the Dark Cheribon cane was the principal sufferer, since that was the kind then quite universally planted. No cane disease has been more studied, and none has a larger literature, but to this day its cause and nature are not understood. The vascular bundles and the tissues of the nodes turn red, the internodes fail to elongate normally, and all of the lateral buds sprout, resulting in a worthless bushy stool resembling a clump of some big grass. For this reason the disease was called sereh, the local name for one of the big Andropogons. While not rapidly contagious from plant to plant in the field, it was hereditary, seeds from infected plants always reproducing the disease. Whether or not the soil becomes infected does not seem to have been determined. The entire sugar-cane-growing

world was searched for kinds that might prove more resistant than those generally cultivated. At one time fully five hundred of the old named varieties were growing in the experimental grounds of the Java Experiment Stations. How unfortunate it is that no adequate descriptions of all these varieties were ever recorded! In this day of plant quarantines, such an opportunity for taxonomic studies is not likely to occur again. Among this great mass of material a few kinds were found that showed real immunity to the disease, notably the Chunnee, from Northern India, and the Red Fiji. Neither of these was suitable for commercial planting, but both were extensively used in cane breeding, and most of the many canes produced in Java are descended in some degree from one or the other of these kinds.

Java is a mountainous country, and it was soon noted that only the lower levels were infected by the sereh. Cane grown at the higher altitudes was free from it, and seed cane brought down from the hills could be planted at the lower levels with little loss, at least for the first season. As ratooning was not practiced, this served to save the situation while the long process of breeding resistant kinds was progressing. Extensive seed beds were established at high altitudes, and for years all of the lowland plantings were supplied with healthy seed from these sources.

It is only through calamities that threaten the very existence of the sugar industry that progress in the knowledge of cane and its culture usually occurs. While times are prosperous planters seem content to let well enough alone and to follow old routine methods. This outbreak of sereh, being one of the greatest calamities that ever befell the sugar industry, has proven to be one of its greatest blessings, since it led to such an extensive study of sugar cane, and especially of methods of cane breeding.

The next epidemic of really historic importance was the outbreak of mosaic in Porto Rico. Just when this disease reached the island is not known. It was first studied by officers of the Insular Experiment Station in 1915, but even then it had invaded extensive areas on the west and north coasts, and had evidently been established for a number of years. At first its identity with the yellow stripe disease of Java and Hawaii was not suspected. It was considered as something new, and was called mottling disease, or, in Spanish "matizado," the name by which it is still generally known in Porto Rico. The announcement that it was a true mosaic was not made until 1918. By that time the fields of the entire western third of the island were quite fully infected and there were many scattered

outbreaks in the rest of the island. Yields in badly infected districts had fallen from an average of 25 tons to about 12 tons and in some districts to as low as 8 tons per acre. Except for the high prices prevailing for sugar, many factories would have been ruined. As it was, a few mills were closed down and large areas of land formerly in cane were diverted to other uses. Between 1917 and 1919 the yield of sugar for the entire island fell off 34 per cent. In some of the most severely infected districts the drop was over 50 per cent.

The disease was finally controlled by the finding and extensive planting of an immune variety, the Kavangire, and by the general adoption of the method of control by eradication, including seed selection and the frequent roguing of the fields. As has so often happened before, this disaster proved a blessing to the cane planters of Porto Rico, since it focused their attention so strongly on better cultivation methods and especially on the study of cane varieties. Up to this time the sugar production of Porto Rico had never exceeded 500,000 tons and it was freely predicted that it would never reach this figure again. In 1919 it had fallen to less than 400,000 tons and there were practically no new lands to be brought into cultivation. However, this same area of old and presumably worn-out cane land, solely by the use of better agricultural methods, was made to produce 660,000 tons in 1925. There could be no more convincing proof of the efficacy of the study of sugar cane and its culture.

Prior to this outbreak, mosaic, or, as it had been called, yellow stripe disease, had attracted but little attention and was considered to be of minor importance. It had, however, been causing heavy losses, the true nature of which was not detected. It now seems quite certain that the failure of the Otaheite and Cheribon canes in Natal, and their complete replacement by Uba, an immune kind, was due to a severe outbreak of mosaic. At least, the few surviving canes of other varieties found there are now found to be fully infected, and it is reasonable to suppose that this was the cause of their commercial disappearance. Later, the so-called "degeneration" of the Preanger canes in Argentina and their complete replacement by the Java hybrid canes, POJ 36, and POJ 213, was clearly due to mosaic. Sugar-cane varieties do not "degenerate" in the ordinary acceptation of that term except as the result of disease, or of lack of fertility and reasonably good cultivation. In this case it seems probable that the disease was introduced in these same Java canes, for, unlike Uba, they are not immune but are exceedingly susceptible. The canes of these kinds growing in Argentina to-day are all completely infected by

mosaic, but they are so tolerant of the disease that their growth and sugar yield are scarcely affected. They are, however, efficient carriers of mosaic, as has been proven on their introduction to both Cuba and Porto Rico.

An historical event of first importance for the sugar industry was the discovery, or as we should say, the re-discovery of the fact that sugar cane sometimes produces fertile seeds, and that new varieties may be produced by planting them. There are indications in the literature that this was formerly known, but for many years it had been considered that all cane seeds were infertile and that the plant had completely lost the faculty of seed reproduction. This impression arose from repeated failure to germinate seed, due either to improper methods of seeding or to the fact that some of the varieties in general cultivation are infertile, while others require cross-pollenization. As stated above, the literature shows that seedling canes had been seen by various observers, but modern interest in the subject dates from the discovery of fertile seeds in Java by Soltwedel in 1888, and, quite independently, in Barbados by Bovell and Harrison in 1889. At first these discoveries were considered interesting but unimportant, since everyone was well satisfied with the varieties in general cultivation and no one wished to replace them. The outbreak of sereh in Java, and the gradual failure of the Otaheite and Preanger canes in the West Indies, from root disease, directed attention to the supreme importance of the variety question and greatly stimulated interest in the new seedlings. They began to be produced in great numbers, especially in Java and Barbados where the modern breeding of cane seedlings began. Interest was not confined to these centers, however, for breeding work was soon undertaken in practically all of the important cane-growing countries and is still being continued with constantly increasing vigor. The outbreak of mosaic in virulent form in so many cane regions has been an added stimulus. It is stated that in India alone 200,000 seedlings were produced in 1925. In Hawaii 32,000 were transplanted to the field in 1925, and about 100,000 were ready for transplanting in 1926. These figures give an idea of the tremendous proportions reached by seedling production. Unfortunately, the enormous labor involved has not permitted the proper testing of so many kinds to keep pace with their production. Unquestionably, many valuable kinds are being discarded through sheer inability to handle and test them properly. Very few varieties are adapted to a wide range of soil and climatic conditions. Naturally, only those particularly adapted to the local conditions where they originate are ever selected for further testing elsewhere.

While the improvements in sugar-cane agriculture have been less important than those in the manufacturing side of sugar production, great improvements in cultural methods have unquestionably been made. These, however, are only locally applicable, and it is difficult to treat them historically. In most countries cane has usually been originally planted on timber lands. In such plantings cultural methods are necessarily primitive and only hand labor can be employed. The use of implements is impossible among the stumps and fallen logs of a new land planting. The most important cultural event in the history of each cane-growing region has been the change from these primitive methods to the more advanced agriculture of cane planting on plowed lands with the use of implements for preparing the land for planting and for the subsequent tillage. This change has usually been a difficult one for the industry and has often been accompanied by losses and economic disturbances. At first, cattle, or sometimes mules, were used as motive power for handling the implements, but in recent years steam plows and gasoline tractors are being more and more widely used for preparing lands, and determined efforts are being made in many parts of the world to popularize the use of small tractors for tillage. It is quite probable that a few years from now will see the mule and the ox completely replaced by gasoline or by alcohol on all modern cane plantations.

Changes are also occurring in the transportation of cane to the mill. Fluming and the use of portable track are of local importance only, and are not adapted to ordinary conditions. The greater part of the cane in the world is, and probably always will be, loaded on carts or wagons and hauled to some convenient point where it is transferred to cars on plantation railroads. This is now quite universally done mechanically with a great saving over hand labor. Many devices are being tried for the mechanical loading of carts in the field, but so far these are still in the experimental stage. So far, the cane is mostly hauled from the field by oxen or mules, but the use of tractors for hauling is increasing rapidly.

Unfortunately, cane must still be laboriously cut by hand. In regions with a shortage of labor, the ability to harvest becomes the limiting factor in cane production. Many attempts have been made in various parts of the world to invent a mechanical cane harvester. Some such machines have been made and have actually cut and cleaned cane, but so far none is a commercial success. The one combining the most practical features was probably that invented and patented by A. N. Hadley, the inventor of the corn harvester now so widely used for cutting and shocking corn. His death in 1912,

FIG. 1.—Hauling Cane with Fordson Tractor. Central Rosario, Cuba.

FIG. 2.—The Hadley Cane Harvester invented by A. N. Hadley, the inventor of the corn harvester so extensively used in the United States. This photograph was taken in April, 1910, in the fields of Central Nueva Luisa near Jovellanos, Cuba. Mr. Hadley returned to Cuba in 1911 and continued work with this experimental machine until he felt that he had worked out all of the details for a successful harvester. He returned to New Orleans in March, 1911, to arrange for the commercial production of the machine but died suddenly a few days after landing. His harvester remained under a shed in the outskirts of Jovellanos until finally broken up and destroyed. As last used it was cutting heavy lodged and tangled cane running over 40 tons per acre, cleaning it perfectly, and cutting it into 3-ft. lengths ready for the mill. The machine was double ended running back and forth across the field, a feature not found in any of the other attempted harvesters. Mr. Hadley expected to be able to put this machine on the market for about $5000.

after the machine was practically completed but before it was put on the market, has deprived the industry of what promised to be a most important aid and has postponed the date of what will be the most important event in the history of the sugar-cane industry—the introduction of a really successful mechanical cane harvester. This machine was able to pick up heavy, tangled cane, cut and clean it perfectly, cut it into lengths, and deliver it into a cart driven alongside. It was operated by only two men and could cut about an acre an hour, and yet it failed to attract the attention of the responsible heads of the sugar industry. After Mr. Hadley's death the machine

FIG. 3.—The Hadley Cane Harvester. Another view.

was allowed to stand under a shed in the outskirts of Jovellanos, Cuba, until it was finally broken up and disappeared—a really unbelievable circumstance. The invention of this machine makes it seem certain, however, that the appearance of a successful harvester will not be much longer delayed.[3] When it comes, it will mark an event of revolutionary importance in the cane industry.

OTHER SUGAR-PRODUCING PLANTS

Of course, sugar is produced commercially by other plants besides cane. Sugar beets have long been a formidable competitor of sugar cane. The infant beet-sugar industry was seized upon by Napoleon,

[3] At present the Falkiner Harvester, invented in Australia, is being given a trial in Cuba.

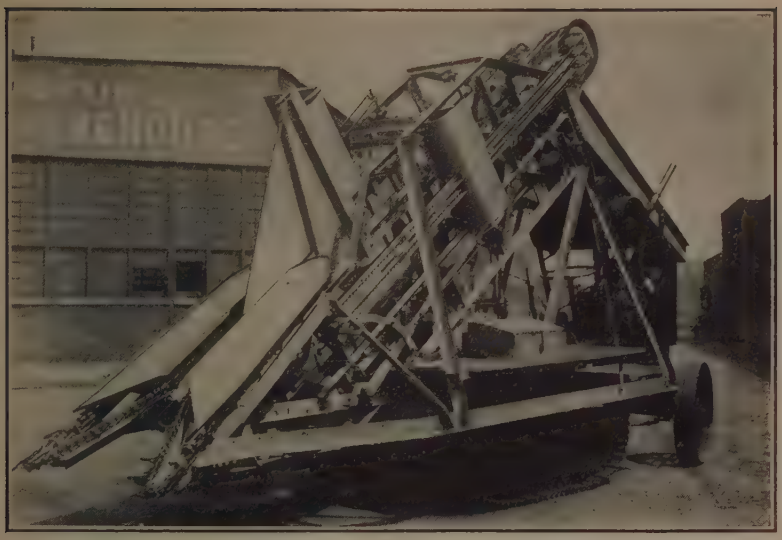

FIG. 4.—The Luce Cane Harvester. This machine has been tried with more or less success in Lousiana, Cuba and Florida. So far it has not been adopted commercially. It is a one-way machine and is much heavier and more expensive than the Hadley.

FIG. 5.—The Falkiner Cane Harvester of Australia as seen at Punta Alegre, Cuba, April 11, 1928.

in his long struggle with England, as a factor of prime importance in countering her control of the seas. He established a system of bounties on beet sugar, which in one form or another persisted up to the beginning of the World War. Although beets have often produced a full half of the world's sugar supply, the industry has always been either bounty-fed or tariff-protected. Beet agriculture has long received much more careful scientific study than has ever been given to cane, and remarkable progress has been made in improving the richness of the beet juices and in increasing the total yield per acre. Notwithstanding this, it is doubtful if beets could stand up against cane in a free competition. Unfortunately or not as we choose to look at it, the sugar industry has long been a football of politics and it will probably always be more or less influenced by political considerations. Sugar has come to be so important a factor in the food supply that nations all seem willing to submit to unnecessarily high prices in order to secure a home-grown supply.

Table syrup has long been made from certain varieties of sorghum. At one time a determined effort was made to make crystallizable sugar from sorghum, but it never was a commercial success. Sugar can also be made from corn stalks and from watermelons, but there is small chance that this will ever be done commercially.

In North America, sugar has long been made from the sap of the hard maple. The total product is not large and will never be materially increased. Maple syrup and maple sugar are to be considered as delicacies or confections and not as competitors in the general sugar supply.

In some parts of the Orient, considerable quantities of sugar and various alcoholic drinks are made from the sap of different species of palms. Recently the extensive Nipe palm marshes of the coasts of the Philippines have attracted attention as a possible source of sugar supply. The labor involved in collecting the sap will probably prevent palm sugar from ever competing successfully with that produced by the beet and the cane.

CHAPTER II

THE PROPAGATION OF SUGAR CANE

Sugar cane is usually propagated by cuttings of the stalks. Each eye or bud is capable of growing and producing a new cane plant. As has already been stated, for many years it was supposed that cane had been so long propagated asexually in this way that, like the cultivated bananas, it had lost the power of producing true seeds. It is now well known that this is not the case; still, these true seeds are never used for propagating cane fields, but only by plant breeders for the production of new varieties. Cane seedlings, even those produced from the same arrow, vary widely among themselves. We may safely say that no two of them are ever exactly alike. Each is the possible progenitor of a new variety. This is one reason, among many others, for not using unselected seedlings for general field plantings. A field so planted would be very uneven in yield and quality, and the great majority of the plants would probably be decidedly inferior to the parent canes from which they came. Canes grown from cuttings, on the other hand, closely resemble the parent cane and produce fields of uniform quality. A variety, once selected and established, must always be propagated by cuttings.

The growing of canes from seed is not particularly difficult for anyone familiar with ordinary greenhouse methods of handling small, delicate seedlings. Any good potting soil can be used successfully. A mixture of well-rotted horse manure, garden loam, and river sand is usually recommended. Preferably, it should be sterilized by heat to destroy any grass seeds or damping-off fungi which may be present. Where this is not convenient, it will be sufficient to prepare the soil well in advance, keeping it well wetted and turning it over occasionally to induce the germination of grass and weed seeds before planting the cane seed. It is more convenient to plant the seed in the shallow boxes known to greenhouse men as "flats," but good results can be secured by planting in raised beds on the ground. Fuzz from ripened cane arrows should be spread evenly over the entire surface to the depth of about $\frac{1}{8}$ inch. A little sand should be sprinkled over the fuzz, enough to keep the water used in sprinkling from washing it

about, but not enough to cover it entirely. If about 2 per cent of some good, complete commercial fertilizer is mixed with this sand, it will aid germination and vigor of growth. The beds or flats must be thoroughly wetted down with a fine-rose sprinkling can or a fine spray, and this must be repeated frequently enough to keep the fuzz continuously moist until the seed has germinated. As with all small, delicate seeds in hot weather, it is necessary to keep the surface closely covered until germination takes place in order to avoid undue surface drying. Some breeders advocate covering the flats with glass and exposing them to the sun from the first. Another method is to cover at first with boards or sacks, but the beds must be watched closely, and these must be removed at the first sign of germination. As soon as possible, the young plants must be exposed to the full sun. Shading is injurious, but care must be taken to water frequently enough to prevent the drying out of the coating of fuzz. Germination may be expected in about five days if conditions are favorable.

At first the young plants are very delicate. They grow slowly and are difficult to transplant. It is best to keep them in the seed flats for about two months, when they can be transplanted easily and with little loss. It is usual to transplant to 4-inch pots or to dirt bands, and not to take them to the field until they are a foot to 18 inches high. It is best to plant in squares or at least to space the young plants as much as 4 feet apart in the row, in order the better to study their normal stooling habits. It often happens that more plants are germinated than can be properly cared for later. This necessitates the early rejection of the more feeble ones. The first opportunity for selection occurs when the seedlings are being first transplanted to pots. A great difference in size and vigor will be noticed even at this early stage. Some of the best plants will begin to show evidences of stooling. Such plants are quite certain to produce heavy, vigorous stools. This, of course, is a first requisite in cane breeding. It is useless to retain for chemical selection canes that are poor stoolers or those lacking in vigor. Another selection can be made when the plants go to the field. By these two selections one can be assured that the new variety field contains only canes with a reasonably good promise for vigor and tonnage.

As the canes reach maturity they must be examined chemically to determine the sucrose content and purity of the juices. It is at this point that breeding operations are likely to be most faulty. Cane varieties vary greatly in the age of maturity. Some kinds may be as ripe at ten months as others are at fifteen. It is obvious that a

single analysis can throw light on their comparative condition at one date only. Many valuable kinds have undoubtedly been discarded simply because they were late in maturing and made a poor showing when an analysis chanced to be made. Variety plots should always be analyzed at least once each month for a considerable period, beginning when the cane is about ten months old. This is the only method of determining with certainty which are early and which are late-maturing kinds, and this is a matter of prime importance in deciding on their utility for different purposes. For instance, it is clear that only the earliest-maturing kinds would be useful in countries with a short growing season, like Louisiana, Argentina, and Northern India. A proportion of late-maturing kinds, or at least of those that remain long in good condition, is indicated for strictly tropical countries with a long growing season. These are points of great practical importance, but they have not always been duly considered, and in the literature of cane varieties there is often a lack of authentic information regarding them. There has been much loose writing about kinds that are either rich or low in sucrose, but there are few real data on which to base these popular opinions. The fact is that most cane varieties, at least among the thick tropical kinds, develop satisfactory sucrose when fully ripe. Most of the so-called low-sucrose canes are simply late-maturing kinds which are usually cut before they are ripe. The cutting of immature cane occasions one of the most serious of the avoidable losses connected with the agricultural side of the sugar industry. There are, however, a few kinds that never sweeten up as they should, and these should be discarded, regardless of vigor and tonnage.

It takes several years to decide fully on the value of new varieties. All of the more promising ones should be replanted with cuttings from these seed-grown, or, as they are often called, mother stools. Full notes should be kept on vigor and stooling and another series of analyses made to confirm the date of maturing and sucrose content and purity. Before releasing new varieties for general plantation trials it is important, too, to test them out under as many distinct soil conditions as possible, since it is only in this painstaking way that their value can be determined. The original seed planting and all of the replantings should be kept for as many years as possible in order to study ratooning habits. The ability to ratoon vigorously for a long series of years is a most valuable character. Ratoon crops are always cheaper than those grown from new plantings. There are very few localities where cane will not ratoon profitably if the proper varieties are selected and the proper cultivation given.

At first, the greater part of the new canes produced were so-called natural seedlings. Seed for planting was taken from the fields where it was most convenient. Such selection as was done was usually the searching for kinds known to produce viable seed, rather than for those with specially desirable characters. At first in Java, and later in many other countries, determined efforts have been made to secure new kinds by hybridization, thus combining valuable characters from widely different parents, as for instance the sereh-disease resistance of the North Indian Chunnee with the high sugar production of the Dark Cheribon. This cross has been the basis of many of the POJ hybrids produced at the East Java Experiment Station at Pasoeroean (Proef-Station Oost-Java). Hybridization by emasculation, the method practiced with so many other plants, is difficult with sugar cane on account of the small size and delicacy of the flowering parts. It has been done successfully on a small scale but is seldom attempted. Advantage is sometimes taken of the fact that some varieties produce little or no pollen while others are infertile to their own pollen. Planting such kinds in alternate rows with a vigorous pollenizer should result in a majority of crossed seedlings. A practical difficulty is that the two kinds may not bloom at the same time, or, as frequently happens in some seasons, one or the other of the kinds may fail entirely to bloom.

The factors governing the blooming of sugar cane are not well understood. Varieties differ widely in blooming habit, some seldom or never blooming under most conditions. Kinds that are normally free-blooming are greatly influenced by differing soil and climatic conditions. To avoid the difficulties arising from erratic blooming habits, breeders are more and more adopting the plan of cutting arrows of the desired male parent just before the anthers open, placing the cut end in a bottle of water to prevent withering and tying it in the top of a cane of the female parent with flowers in which the stigmas are just becoming receptive. With a gauze covering over both inflorescences to keep out insects, the chances are good that any seed produced will be cross-pollinated. Of course, kinds that are usually infertile to their own pollen should be selected as mothers. The greatest inconvenience with this method is that the staminate arrow remains in good condition only for a short time. It is usually necessary to renew the arrows daily. It is found that a little sulphurous acid in the water in the bottle will keep the arrow in condition for a longer period. One part to the hundred of a 5 per cent solution of SO_2 is recommended.

In recent years the widespread occurrence of mosaic has centered

attention on Uba[1] and other allied immune kinds as parents. Uba is a very remarkable cane. It is not only completely immune to mosaic but also to gum disease and practically so to root disease and to Matz vascular-bundle disease. It is hardy and drought-resistant and will produce good crops on lands too poor and too much exhausted for profitable planting to Cheribon or other thick, tropical canes. It is a late variety, but when fully matured it yields as much or more sucrose than the Cheribon and Preanger kinds. Its only real drawback for general planting seems to be that the trash sticks to it so closely that it is difficult to harvest. This difficulty will be obviated when we finally get the long-looked-for mechanical harvester.

Unfortunately, more than one kind is being planted in different parts of the world under the name of Uba. They are closely similar in appearance, all belonging in the *Saccharum sinense* or *Pansahi* group. They are all equally immune to mosaic and about equally hardy and prolific, but they differ considerably in their value as sugar makers. The true Uba seems to be decidedly the best of the lot. This is the cane so long and successfully grown in Natal. It went to Mauritius under this name from Brazil in 1869. It doubtless has other perfectly good and much earlier names in India whence it is supposed to have been carried to Brazil, but thus far it has not been possible to connect it with certainty with any of these older names. Among the recent importations from India, it most closely resembles the Merthi, with which it has been identified by some, but these varieties resemble each other so closely and are so difficult taxonomically that positive identification is exceedingly uncertain. The cane so extensively planted as Uba in Porto Rico also came from Brazil but by way of Argentina where it was known as Kavangire. It is closely similar to the cane grown in Natal, but when they are planted side by side slight differences can be detected. They are about equal as sugar producers, but in the Kavangire the trash is still more objectionably adherent than in Uba, and the evidence at hand indicates that the sugar content is much more likely to be lowered by weather changes toward the end of the season.

The cane known as Uba in Hawaii is probably the Zwinga, long planted in the southern United States as a forage under the name of Japanese fodder cane. At least, the original stock came from Louisiana in the early days, and this is the only variety of this type known to have been there at that time. While hardy and disease-

[1] Recent reports show that Uba and other so-called immune kinds are occasionally attacked by mosaic. This, however, occurs so rarely that for all practical purposes they may be considered immune.

resistant, it is poor in sugar. It is unfortunate that the cane breeders of Hawaii have used this instead of the true Uba as the basis for their crosses.

These canes are so hardy and disease-resistant and give such tremendous tonnage, even under unfavorable soil conditions, that they naturally appeal strongly to cane breeders. A cross between this type and the best of the thick, tropical canes, if it chanced to combine the best characters of both groups, would be a prize worth any effort to secure. The pollen of these kinds usually seems to be either abortive or infertile, so that self-pollinated seedlings are rarely secured. This would seem to be an advantage in producing hybrid kinds, but for some unknown reason cross-pollination has also proven difficult. Comparatively few cross-breed seedlings have been produced, notwithstanding the numerous efforts to make them.

This difficulty in securing Uba hybrids freely has centered attention on another group of hardy immune canes as parents. During the long search in Java for canes with which to combat the Sereh disease, a wild cane of great vigor was found in the mountain slopes back of the town of Cheribon in Java. Wild canes of the *Saccharum spontaneum* type are abundant in these hills, but this was clearly different, and, under the name of Kassoer, it was brought into the breeding work of the East Java Station. It is one of the most remarkably vigorous canes known, but, unfortunately, it does not develop sucrose enough to make it commercially profitable. Cytological studies indicate that it is of hybrid origin, and the usually accepted opinion is that it is a natural hybrid between the wild cane and the Black Cheribon once so widely cultivated in that region. This view is strongly supported by artificial crosses between these kinds, which have given offspring closely similar to Kassoer. The fact that this cane is completely immune to mosaic was not particularly considered in this earlier breeding work, but its great vigor and immunity to Sereh caused it to become an important factor in the later series of POJ hybrids.

In POJ 2714 and 2725 and others we have secondary hybrids carrying only one-fourth of Kassoer blood and consequently presumably only one-eighth of the wild *Saccharum spontaneum.* These are stout canes of great vigor and fine appearance, and develop as much sucrose as most of the better of the *Saccharum officinarum,* or so-called noble canes. They are being planted to some extent on a commercial scale in Java,[2] where they are said to be immune to Sereh.

[2] The later produced POJ 2878 of the same parentage is rapidly becoming the chief commercial cane of Java.

They are not absolutely immune to mosaic but it is claimed that they are both resistant and tolerant, taking the disease rarely and then being little injured by it. POJ 2727, with much the same characteristics, is a cross of the same female parents on Batjan instead of EK 28. Another secondary hybrid from Kassoer produced at one of the Java plantations, which is attracting much attention, is Tjepering 24. It is one of the few stout canes known which is absolutely immune to mosaic. It is not as vigorous on most soils as the POJ kinds just mentioned, but it is very rich in sucrose and early in maturing. In a series of variety tests in Cuba, it took first place in sucrose in juice out of one hundred and ten kinds at one series of analyses, and third place in two other series. This demonstrates conclusively that it is possible to combine the high sugar content of the best *Saccharum officinarum* canes with the disease resistance of *Saccharum spontaneum*. It shows equally clearly that cane breeders are now taking the right road and that they will ultimately give us cane varieties far superior to those which now furnish the world's sugar supply. Notwithstanding the noteworthy success in Barbados and elsewhere in crossing and selecting varieties of the noble canes only, work which has resulted in giving us such splendid kinds as BH 10(12), SC 12(4), and H 109, it seems quite certain that the best canes of the future will carry enough of *Saccharum sinense* or *Saccharum spontaneum* blood to insure greater vegetative vigor and disease resistance.

Another group of canes that is attracting serious attention from cane breeders resulted from the early work of Kobus in Java in making crosses between the North Indian Chunnee and the Cheribon and Preanger canes. These are included in the earlier numbers of POJ canes, those that have attracted most attention being POJ 36, 213, and 234. The Chunnee belongs in the Saretha group, as the North Indian canes have been classified by Barber. These canes quite closely resemble some forms of the very variable wild cane of that region and they are supposed to be descended from them. Here again we have an instance of the unsatisfactory state of the botany of sugar cane, since these wild canes, like those of Java, are by most modern botanists also referred to *Saccharum spontaneum*, the only wild species of sugar cane that is recognized by them. The older view that there are a number of wild species is probably more nearly correct, as we should discover if we knew how to distinguish properly between them; at least, the breeder soon finds outstanding differences. Chunnee and all of its descendants are very susceptible and also very tolerant to mosaic, and not immune like Kassoer and its wild ances-

tors. They all take mosaic freely but are very little injured by it. They also show a decided tolerance to cold, as is natural in view of the climate of the country from which they came. Neither their cold resistance nor their behavior to mosaic were of interest to the makers of these crosses. They were made and retained because of their immunity to Sereh, a quality they have in common with the Kassoer seedlings; but even this did not secure them a wide acceptance in Java. They have come, however, to have an accepted place in the warfare with mosaic but are likely to be most useful in extending successful cane culture in subtropical regions.

Jeswiet has recognized the difficulty of reconciling the differences between these groups of canes by making a new species, *S. Barberi* for these North Indian canes. This species, however, is supposed to include only the cultivated varieties. Their possible derivation from the native wild canes, and the relationship of these to the wild canes of the East Indies still remain open questions.

As was stated at the beginning of this chapter, all commercial fields are planted with cuttings of the cane stalks. These are usually short pieces one to two feet long and carrying from two to four buds. Sometimes, as in Louisiana, the entire stalk is laid down in the planting furrow. Where planting is done mostly during the crop season when cane is being cut for the mill, it is customary to use the top cut as seed for planting. These joints, being less mature than the body of the cane, germinate more quickly and vigorously, and besides they are of less value for sugar making. This is the prevailing custom in most cane-growing countries. As indicated above, it is not followed in Louisiana and it is seldom practiced in Cuba where shortage of labor and the prevailing dry weather usually make planting impracticable during the grinding season. Where whole, or body, seed is used it is important to select canes that are not too ripe. Fields from eight to ten months old make the best seed. It is not important whether they are plant or ratoon fields, but if the latter they must be in good vigor and production. The practice, so often followed, of using the poorest, half-abandoned ratoons for seed cannot be too strongly condemned.

It is often necessary, or at least convenient, to cut seed cane some days in advance of planting. In such cases the piles should be covered with trash to keep off the sun and prevent drying out of the cut ends. Sprinkling the piles occasionally is often advocated, but this is seldom necessary with the thick, tropical varieties which will keep a considerable number of days without injury if protected from the sun. The thin varieties, especially the *Saccharum sinense* kinds,

loose their vitality more quickly. They are all strong germinators when cut fresh, but to secure full stands they should be planted within three or four days after cutting. In some countries it is customary to soak the bags of seed cane in water before planting. This hastens germination and has the added advantage of killing such borers and mealy bugs as are in the stalks. It is claimed that soaking for forty-eight hours in cold water is as effective for this purpose as dipping in hot water, which is also recommended. At one time it was often advised to dip seed pieces in Bordeaux mixture before planting. On some plantations, especially in Porto Rico, this has been widely done, but it is doubtful if it has ever paid for the inconvenience and expense involved. When soil conditions are not favorable for prompt germination, it will doubtless tend to protect the seed piece from being attacked by the pineapple fungus or other rot organisms, but it can have no effect in preventing mosaic, root disease, or any of the other serious cane diseases. In Louisiana and other subtropical cane countries, it is often necessary to protect seed cane from frost by banking it with earth. This also prevents drying, and with the cool temperatures prevailing the cane can be kept safely for several months. Of course, in warm weather the buds on such buried cane would sprout and the material would be lost. Methods of planting this seed material will be discussed in the chapters on cultivation.

While it is true that cane grown from cuttings usually closely resembles the parent type and that fields planted with them are fairly uniform and representative of the variety, still it cannot be said that two canes are ever exactly alike. There are always differences between them, due in part to the vigor of the bud from which they spring, but more particularly to the fertility of the spot where they chance to grow. Such vegetative variations are for the most part not inheritable. At least it is an open question to what extent and under what conditions such characters acquired from the environment may be inherited. Many attempts have been and are still being made to improve cane varieties by the continued selection of the best individual canes for planting. At first, most of the attempts centered around the chemical selection of the seed material in the attempt to increase the sucrose content and purity of the juices. This involved so many difficulties that recently interest seems to have shifted to the selection of the more vigorous, disease-resistant and better-stooling canes. There can be no question at all that a big, vigorous seed will give a better plant than a poor, half-starved, stunted one. Careful selection of the best available seed material is one of the most important factors

in securing a satisfactory yield. However, it is still unproven that this method of mass selection can permanently improve a variety or change any of its characteristics.[3] There seems to be strong evidence that the principal characters of the original seedling are usually handed down unchanged through an unlimited number of bud cuttings. The old Creole cane has been known in its present form in America for four hundred years. The Otaheite, when introduced a hundred and fifty years ago, seems to have been the same cane that we know to-day. The Pandia cane of India has been known for two thousand years.

If, then, there is no sure expectation that we shall ever be able permanently to improve or change the characters of a variety by constantly selecting the best canes for seed, there is the compensating assurance that our favorite varieties are not degenerating and running out, but that by attention to good cultural methods and the selection of vigorous seed material they may be maintained indefinitely with their present value. The literature, not only of sugar cane, but of many other crops, is full of lamentations over the supposed running out or degeneration of favorite varieties. There seems to have been a widespread opinion that varieties of cultivated crops were short-lived, that they had a natural tendency to degenerate and disappear. This idea was at first one of the strongest motives for the propagation of new seedling varieties of cane. Notwithstanding its wide acceptance, it has never been supported by convincing proof of any kind. With plants that are usually propagated by seed, there is always the danger that a variety may be lost through mixing with other kinds by cross-pollination. There is no such danger with plants propagated vegetatively, as by cuttings. True, such varieties are constantly changing in popularity. They may be dropped because superseded by better kinds, they may be so susceptible to some disease or insect attack as to be no longer profitable, or they may no longer be adapted to changing soil conditions. Soils frequently deteriorate, even if varieties have no inherent tendency to do so. Concord grapes, Bartlett pears, and Elberta peaches are grown to-day on untold thousands of acres, but there is no evidence that they are less vigorous and productive than at the time of their first introduction. The same is true of cane varieties. The Crystalina, White Transparent, or Light Preanger, as it is variously called, is an old, long-established variety whose history can be traced back for over two hundred years; but

[3] Recent work in Louisiana seems to indicate that it may be possible to increase disease tolerance by mass selection. See Edgerton and Tims, La. Bull. 197.

to-day it is more widely planted than any other one cane variety and there is no sign that its vigor and productiveness have ever diminished.

The foregoing discussion does not by any means imply that there is no such thing as bud variation, nor that the attempt to improve varieties by asexual selection is necessarily hopeless. Nothing is more clearly proven than that well-marked sports or mutations are occasionally found in cane fields. These usually take the form of abrupt color changes, or, at least, color variants are so conspicuous that they are the ones most often noticed. Certain buds on a solid-colored cane may develop into canes with conspicuous striping, or a striped cane may revert and give rise to solid-colored canes, the color following either the light or the dark stripe. Sometimes as many as four or five color forms are found within what is known to have been originally the same variety. Thus the Cavengirie, which is normally a claret-colored cane with a bronze stripe and faint white stripings on the leaf sheaths, may be either solid claret, solid bronze, or claret with white stripes, or the white striping may extend up into the leaf blades. Many of these color variants have been given names and have been widely cultivated as distinct varieties. Good examples are the three Preanger canes, which have all been widely planted under a great number of different names. In America the light form is usually known as Crystalina or White Transparent, the striped form as Louisiana Ribbon or Striped Mexican, and the dark as Louisiana Purple. The widely planted Yellow Caledonia or Light Tanna, also appears as Striped Tanna or Big Ribbon, and as Black Tanna. At least four color variants of Otaheite have been recorded, and one, the Green Ribbon or Calancana, has been widely planted. These color forms, when found, can be easily perpetuated by cuttings since they usually come true, only on rare occasions reverting to the color from which they originated.

To what extent other characters are correlated with this change in color has not been clearly determined. Popular opinion is convinced that there are such correlations. Thus, Louisiana Purple is supposed to be earlier in maturity than Crystalina and for that reason has been propagated by preference in Louisiana. Planters on the north coast of Porto Rico prefer the striped or Rayada form, while on the south coast the Crystalina is much more widely planted. All planters in Cuba agree in preferring the Crystalina, and many of them have taken great pains to breed out the striped form; but, as a matter of fact, no real evidence exists to support any of these preferences. This is a question that deserves much more careful study than it has ever received, for it seems incredible that such well-marked

and easily inheritable color changes should stand entirely alone. It is the hope that there are other bud sports, in less easily detected directions, that are giving rise to strains within the variety that are more vigorous, heavier-stooling, more disease-resistant, or richer in sucrose, that justifies the continued interest in asexual or bud selection in so many parts of the world. The subject is admittedly a difficult one, but it is by no means insoluble; and the present efforts, if persisted in for a few more years, should show definitely whether or not tangible results are to be expected.

CHAPTER III

THE BOTANY OF SUGAR CANE

The multitude of varieties of cultivated sugar cane all belong to the genus *Saccharum*, as at present recognized by botanists. The genus was founded by Linnaeus in the First Edition of the "Species Plantarum," published in 1753. He there included two species *S. officinarum*, the tropical cultivated sugar canes, and *S. spicatum*, which is now excluded from the genus. The number of supposed species increased rapidly. Thus Wildenow, in the Third Edition of the "Species Plantarum," in 1797, lists eleven species; and Kunth in 1833, in the "Enumeratio Plantarum," lists twenty-two species besides numerous varieties. Roxburgh, in his "Flora of India," in 1832, gives eleven species for that country alone, eight of them being described as new. Hooker, in the "Flora of British India," 1897, reduces the number to five. Bentham and Hooker, in "Genera Plantarum," 1883, recognize twelve species for the world. Hackel, in his revision of the grasses for Engler and Prantl's "Pflanzen Familien," 1887, still the recognized grass authority, also gives twelve species, but only two of them in the section *Eu-Saccharum* or the true sugar canes, these two being *S. officinarum L.*, the cultivated tropical canes, and *S. spontaneum L.*, the wild cane of India and the Pacific Islands. In this he has been followed by most modern writers. The attempt, however, to include all known cane varieties in only two principal groups or races has proven difficult, and efforts have been made to find a more rational classification. Barber[1] has shown that the wild *Saccharum spontaneum* of India is an exceedingly variable species, showing forms with practically all of the different characters by which we distinguish between the different cultivated varieties. No one, however, seems to have made a careful, detailed study of these wild forms in recent years or to have compared them critically with the wild canes growing in the Pacific islands. Such a study would almost certainly enable us to distinguish well-marked groups among them, and would probably throw light on the origin of some of the groups of cultivated canes. Dr. Jeswiet, of Java, who has

[1] C. A. Barber, Punjab Canes, Mem. Dept. Agr., India, 1, 1915.

given in recent years most study to sugar-cane classification, and who now recognizes four species, bases three of them entirely on cultivated forms and still includes all of the wild canes of the world under *S. spontaneum*. It is indeed remarkable that no wild representatives have been found for the three principal races of cultivated canes. All we know is that they must have been of Asiatic or South Pacific origin, since no true sugar canes occur naturally in any part of America.

Jeswiet's[2] four species include the two Linnaean species practically in their original sense, *S. spontaneum* including all of the wild canes and *S. officinarum* all of the thick, tropical or so-called "noble" cultivated varieties. He takes up the *S. sinense* of Roxburgh to include the Uba-like canes so extensively cultivated in China, Japan, and Formosa, and he makes a new species, *S. Barberi*, based on the Chunnee, so much used in breeding work in Java, to include the cultivated canes of Northern India. He distinguishes these four species by the following key which is transcribed from the above-mentioned work.

KEY TO THE GENUS SACCHARUM[3]

1. Principal axis of the inflorescence long-haired. Of the paired flowers, the stalked one blooms first. Stalks green, gray-green, green-brown, or ivory white. Glumes always 4..... 2.

1. Principal axis without long hairs, usually glabrous, sometimes a few weak, widely scattered hairs on the rachis. Glumes usually 3, sometimes 4. Lodicules not ciliate. Of the paired flowers, the sessile one blooms first.....*S. officinarum, L.*

2. Lodicules ciliate. Underground rootstalks long. A wild species.... *S. spontaneum, L.*

2. Lodicules not ciliate, underground rootstalks short. Cultivated sugar plants ..... 3.

3. Leaves broad (up to 5 cm.), long, and drooping, internodes usually spindle-shaped. Stalks greenish-brown, (Uba type)..... *S. sinense,* Roxb.

3. Leaves narrow and short, usually erect, inconspicuous kinds. Internodes usually cylindrical. Stalks gray-green, white, or ivory white (Chunnee type).....*S. Barberi,* Jeswiet.

[2] Dr. J. Jeswiet, Archief voor de Suiker industrie, 12, 1925. Bijdrage tot de Systematick van het Geslacht Saccharum.

[3] Since the above was written an English translation of this Key by Jeswiet has been published. Proc. 2nd Conf. Int. Technologist, p. 138.

It will be seen that Jeswiet distinguishes *S. officinarum* from the other three kinds by the facts that of the paired florets the sessile will always bloom first, that the glumes are often reduced to only three, and that the principal axis of the inflorescence is smooth or nearly so and not conspicuously hairy. These are sufficiently good technical botanical characters and they are supplemented by the different habit of growth and usually much thicker stalks and broader leaves.

Saccharum spontaneum is distinguished from the two remaining kinds by its ciliate lodicules and long underground rootstalks. Again, the characters are sufficiently satisfactory, especially since they are supported by well-marked inheritable characters such as immunity to mosaic and sereh.

The groups of varieties representing the other two species are certainly different enough in appearance and cultural characters, but there seems to be a lack of good technical points on which to separate them. The long, drooping leaves of Uba are very characteristic of the whole group and can be distinguished at a glance from the shorter, usually erect leaves of the other type, but this would not hold as a good specific character. The enlarged nodes of the Uba are also characteristic, but in Kavengire of the same group the stalks are usually cylindrical or nearly so.

Evidently the last word has not yet been written regarding sugar-cane taxonomy. The field is an open and inviting one. Probably in the future considerably more than four species of sugar canes will be recognized. These will necessarily be based in great part on floral characters for these usually give the best key to actual relationships. However, for the purpose of recognizing varieties in the field characters taken from the inflorescence are of little value, since canes are only in flower for so short a time and since in many localities there are so many kinds that seldom or never bloom. Varietal characters, to be useful, must be taken from vegetative parts which are always present. Even these must be selected with care and must be drawn from parts that are fully matured but not over-ripe, since even such characters as the form and appearance of the bud change somewhat with the age of the cane.

In order to be useful, a cane description should cover notes on all of the following points:

1. General habit; whether erect or soon prostrate, heavy or light stooling habit, general vigor, ability to ratoon and propensity to arrow.

2. The stalk as a whole; average diameter, color, and bloom (waxy

coating). In the following descriptions, canes under 3 cm. in diameter will be characterized as slender; those about 3 cm. as medium-slender; 3 to 3½ cm. as medium; 3½ to 4 cm. as medium-stout; and above 4 cm. as stout or very stout. Of course, such measurements refer to the average for ordinary well-grown canes, not to half-starved ratoons or to overgrown suckers. Color of stalk is one of the most obvious characters, but it can be one of the most misleading, since in many varieties color is dependent on vigor of growth, exposure to light, and the nature of the soil. This is particularly true of that large number of varieties which are normally green but which show a more or less pronounced pinkish, reddish, or brownish flush on exposure to light and air. In descriptions color should refer to that of fully matured internodes which have been exposed by the falling of the leaf sheaths but which have not yet become faded or discolored. Normal changes in color on ripening should be noted. It is important to note carefully the amount of the waxy coating or bloom, but this is a character somewhat dependent on growth conditions.

3. The characters of the internodes: Here should be noted comparative length, though this can be stated only in general terms, being largely dependent on growth conditions, and often varying widely in different parts of the same stalk; general form, whether cylindrical, compressed, barrel-shaped, or spindle-shaped; whether it is enlarged either above or below: whether the internodes are straight, all lying in the same direction, or staggered, each one differing a little from the last in direction; and finally whether or not there is a groove or furrow on the side above the bud and, if present, something regarding its appearance.

4. The nodes: whether constricted, even, or enlarged, and whether at right angles to the stalk, or oblique. The node consists of several elements which should each be noted. These are as follows:

(*a*) The growth ring: This is a narrow region separating the node from the internode above. It may differ in color or be concolorous and it may be sunken, even, or elevated. The width is also quite variable and should be recorded. The cellular tissue of this region remains in a plastic growing condition longer than the rest of the stalk and by its growth enables the young cane to resume an erect position when thrown down by the wind.

(*b*) The root band: This is the space between the growth ring and the point of attachment of the leaf sheath. In different varieties it varies from as little as 6 mm. to 12 mm. or more in width. It is generally a somewhat different shade of color from the internode and is marked by irregular circling rows of rounded dots which mark the

ends of rudimentary roots. These quickly grow out and form a new root system when cuttings are planted in moist soils. In some varieties they tend to spring into growth prematurely on the standing cane. The number of rows and the color, size, and prominence of the rudimentary roots should all be noted.

(*c*) The leaf scar: This is a remnant of the base of the leaf sheath which remains on the stalk when the leaf falls away. It is usually prominently squarrose under the bud, and may be so on all sides, but it is more often closely appressed to the stalk behind, on the side away from the bud. In very young joints of cane there is usually a conspicuous circlet of long hairs on the base of the leaf sheath. These are usually deciduous, falling away before the maturity of the leaf and thus leaving the leaf scar glabrous. In a few varieties, however, they are persistent, leaving the leaf scar conspicuously ciliate. This is usually a constant character of considerable diagnostic importance.

(*d*) The glaucous band: This name is applied to a region, usually about a centimeter wide, immediately below the leaf scar. It is characterized by a heavy deposit of wax, even in those varieties in which otherwise this material is scanty or wanting. In fact, it is with the kinds of little bloom that the glaucous band is most conspicuous. Where there is a heavy bloom it may be quite completely obscured. Often, although not always, this band may be conspicuously sunken or constricted. Sometimes this and sometimes the root band constitutes the narrowest part of the stalk. In most of the *S. sinense* or Uba-like varieties these parts are usually swollen and have a greater diameter than the internodes.

5. The buds: These give us characters of greater taxonomic importance than any other part of the cane. Bud characters are less variable and less dependent on growth conditions than any of the others, and it is on their careful description that we must mainly depend for recognizing varieties. If this had been thoroughly understood by the older writers it would have prevented much of the unfortunate confusion existing in the literature of the subject. Although affording the most stable characters of any part of the cane plant, the appearance of the bud varies greatly at different ages and stages of development, and judgment and experience are required to determine whether or not a given stalk shows buds that are in a typical condition. Unless otherwise stated, bud descriptions should apply to those buds that are fully grown and developed but have not started to germinate on the standing stalk. With some varieties this is likely to happen soon after the bud is mature. On stalks that

have arrowed, the buds often change their appearance considerably. As a rule, cane that is about ten months old is in the best condition for study.

Under the bud should be noted the general form, whether lanceolate, ovate, oval, suborbicular, or broader than long; the apex, whether acute or obtusely rounded; the flat sterile margin, whether narrow and uniform in width, broad and uniform, or shouldered, that is, abruptly widened below; the point of germination, whether apical, subapical, subdorsal, or dorsal (so-called when the germination point issues near the center of the bud and not at or near the apex). The average size should be given, especially in relation to the other elements of the node, as in some cases the buds do not reach to the growth ring while in other kinds they may exceed it by as much as half of their length. Finally, the presence or absence of hairs should be noted, and, if present, the characters of the investiture and its abundance, especially at the base where there are usually places of felted hairs, and along the sides and at the apex. In a few kinds the entire back of the bud may be hairy. In others, a short vestiture tends to follow the veins. When mealy bugs are present at the nodes they frequently eat off these hairs. Such buds should not be selected for study.

6. The leaf sheaths: In many varieties the leaf sheaths have a dense vestiture or coating of sharp, stiff hairs over the greater part of their surface. This was often referred to as "cane itch" by the older writers, since these sharp hairs prick and irritate the skin of persons handling the cane. This vestiture may be persistent, or it may be more or less deciduous, appearing only on the younger sheaths and falling off at maturity. Its general character and abundance and the color of the hairs should be noted. In other varieties this vestiture is reduced to a few scattered hairs along the median line on the back of the sheath, or it may be entirely absent. Such sheaths are called "glabrous" or, if only a little hair is present, "glabrate." If much wax appears on the sheath it is called "glaucous." The color is usually green but it may be tinted with red, purple, or lilac. In a few varieties it is dark purple. In connection with the sheath the following points should be noted:

(*a*) The throat: This is a discolored, usually more or less crumpled or wrinkled area in the axil of the leaf where the blade joins the sheath. It is usually lannate, that is, coated with numerous short, appressed, wool-like, more or less felted hairs, but it may be only waxy or glaucous. Usually there are conspicuous tufts of long hairs at the margins. All of these characters should be noted.

(*b*) The collar: This is the corresponding region on the outside of the leaf. It consists of two more or less clearly marked triangular discolored areas which may or may not meet and coalesce at the midrib. The surface may be lannate or only glaucous.

(*c*) The ligule: This is a short, circular, usually brown, somewhat horny membrane that clasps the stalk at the base of the leaf blade. It varies somewhat in length and shape in the different kinds, and the edge may be nearly even, or fimbriate.

(*d*) The ligular processes: This name is used by Barber for the triangular outgrowths or lobes seen in some varieties at the upper corners or shoulders of the leaf sheaths. These may be large or small, broad and obtuse, or slender and acute. They may be present on one shoulder or on both, or they may be entirely absent.

7. The leaf blade: The general position should be noted, whether spreading and drooping, erect with the tips declined, or strictly erect. The color may be light or yellowish green, dark green, or glaucous or bluish green. Measurements of the average width should be given. Finally, the character of the serrations on the margin should be noted, as well as the presence or absence of long hairs or cilia on the margins at the base.

8. A full description should include the characters of the arrow or inflorescence. These characters are especially valuable in determining the specific relationships, or the race to which varieties belong, but for practical reasons they are ignored in the following descriptions.

With all of the above characters noted, it should be fairly easy to locate any of the kinds described in this volume by the use of the analytical key (see p. 38). The easy handling of such keys, however, requires some practice, and care is always needed not to be thrown off the trail by the variability of some of the characters used. This is especially necessary in regard to the color of the stalk and the presence of a vestiture on the leaf sheath, particularly in those kinds where this is more or less deciduous.

Botanical keys usually follow one of two general plans. They are either bifurcated or indented. The first plan is employed here, the two or more characters to be contrasted being arranged under the same guide number at the left of the page, other guide numbers at the right showing where each group is again discussed and further subdivided.

CHAPTER IV

THE VARIETIES OF SUGAR CANE

The number of cane varieties to be found in different parts of the world is very great, and each year it is being increased by multitudes of new seedlings. In the following annotated list[1] of cane varieties there have been collected over seventeen hundred names that have been applied to cane varieties, and this without attempting to include the long series of numbered seedlings. It seems to be the fashion to call only these newer kinds seedlings, although it is quite certain that the greater part of the older named kinds also originated as seedlings, perhaps in most cases as self-sown seedlings. Only a very few are known to have originated as bud sports.

Considering the immense practical importance of the subject and the vast amount of material available, it is indeed strange how little real study has been given to cane varieties. Large collections have frequently been assembled, but this has usually been in the search for kinds resistant to some special outbreak of disease and the opportunity has not been utilized for studying them taxonomically, for drawing up recognizable descriptions, or for determining synonymy. At one time the Java cane experimental stations had between four and five hundred named varieties in their collections, but we have no knowledge of most of them beyond a list of their names and the countries from which they came. Other large collections which should have resulted in real knowledge of varieties existed at the Botanical Gardens at Rio de Janeiro, in Mauritius, Jamaica, Louisiana, Australia, Barbados, Argentina, and Hawaii. In no case was the opportunity fully utilized. Stubbs, in Louisiana, called attention to certain synonyms in his collection, and Eckert, in Hawaii, carried this work still farther. It is, however, to the observations of Noel Deerr that we owe most of our present scanty knowledge of cane variety synonymy. It is certain that the same variety has often been known in different countries under different names. Conversely, the same name is sometimes used for an entirely

[1] See Appendix I.

different variety. All of these cases must be sorted out and the correct names determined before we can understand properly the records in the literature. The older varietal descriptions are sometimes so well drawn as to leave little or no doubt regarding the kind intended. For the most part, however, they are mere vague notes on color or perhaps on general growth habit and have but slight diagnostic value.

Cultural varieties of plants have long been the bane of the systematic botanist. He usually avoids them as he would the plague; but in recent years Barber, in India, and Jeswiet, in Java, have laid a firm foundation for sugar-cane taxonomy by publishing such full and detailed descriptions that their varieties are as easily recognized as are the species of wild plants in standard botanical manuals. While their systems are essentially the same, Jeswiet has perhaps over-emphasized the importance of the number and arrangement of the plant hairs. Barber has seemed to follow more closely ordinary botanical usages and has striven to give due value to all of the morphological characteristics of the variety. His method has therefore been adopted in the descriptions of the principal commercial cane varieties which follow. With the key which accompanies them, it is hoped that they may be recognized as readily as are any of the species in large, closely related groups of wild plants.

THE PRINCIPAL COMMERCIAL VARIETIES OF SUGAR CANE

In the following pages will be found a botanical description and an agricultural valuation for each of the more important commercial sugar-cane varieties. A few are also included that are only of historical interest or that are of importance for use in plant breeding. Descriptions were not available for a few of the kinds now being planted commercially in Mauritius, Australia, and some other cane-growing districts.

As a matter of convenience, they are arranged in alphabetical order, which often serves to separate closely related kinds; but in the analytical key to the descriptions the attempt has been made, for the first time, so to arrange them that the botanically related kinds are grouped together. First come Creole and Negrita, which are clearly related but of somewhat uncertain botanical affinity. Next come the important group of the *Saccharum sinense*, or Chinese canes (the Pansahi canes of Barber), then the half-bred *Saccharum spontaneum* canes, then the *Saccharum Barberi* hybrids or North Indian group, and finally the noble canes and hybrids with a large proportion of

this blood. The grouping is a matter of much practical importance since it is now well understood that each of these groups is related by important cultural as well as botanical characters. Thus, the noble canes are usually good in sucrose content and of a desirable free-milling texture, but they are all susceptible to mosaic, and are likely to suffer from root disease on all but the best types of cane lands.

The *Saccharum sinense* canes are immune or practically immune to mosaic, and their strong root system and great ratooning power adapt them admirably for planting on poor lands. They are all slender canes and late in maturing, but they finally develop a good sucrose content. They are higher in fiber than the noble canes, the bagasse consequently having a higher fuel value, and being better adapted for the production of building-board.

The *Saccharum Barberi* hybrids have considerable resistance to cold, thus being adapted to subtropical climates. They also have strong root systems, enabling them to thrive on comparatively poor lands. Most of them develop good sucrose content. They, too, are slender canes with a rather high fiber content. Some are early and some are late in maturity.

The wild cane, *Saccharum spontaneum,* has too little sugar to be considered commercially. Even the half-bred hybrids, like Kassoer, are too poor in sugar, but hybrids with as little as one-eighth of this blood often show its disease resistance and vegetative vigor in a marked degree. The big-barreled POJ canes of the later series are the best-known examples and are now attracting more attention in all parts of the world than any other cane varieties.

Key to Cane Variety Descriptions

1. Stalks more than 2½ cm. in diameter. Leaves usually more than 5 cm. wide: The noble canes or hybrids with a large proportion noble blood (*Saccharum officinarum*) ..... 18.
   Stalks averaging 2½ cm. or less. Leaves averaging 5 cm. or less *Saccharum sinense* varieties, and hybrids with a considerable proportion of *S. Barberi* or *S. spontaneum* blood..... 2.
2. Stalks short, 2 to 2½ m., often a little more than 2½ cm. in diameter. (This group may belong to *Saccharum officinarum*)..... 3.
   Stalks tall, 3 m. or more..... 4.
3. Stalks green to yellow. Leaves green, erect.....Creole.
   Stalks purple. Leaves purplish.....Negrita.
4. Ligule with the ends narrow but an abrupt triangular widening at center; texture thin, green, ligular processes none; the Chinese or Pansahi canes. Stalks greenish; *Saccharum sinense* Roxb.... 5.

Ligule with the center broadly rounded; texture coriaceous, brown. Ligular processes usually well developed, sometimes wanting: Mostly hybrids of *S. Barberi* and *S. spontaneum* ..... 9.

5. Rudimentary roots normally in 2 rows ..... Java Unknown.
Rudimentary roots normally in 3 rows ..... 6.

6. Buds ovate, the apex acute ..... 7.
Buds ovate, the apex obtuse ..... 8.

7. Nodes normally of same diameter as the internodes, the lower one sometimes enlarged; trash clings closely ..... Kavangire.
Nodes conspicuously enlarged; trash a little less closely clinging. A closely related group with no clear-cut distinguishing characters but some cultural differences (see descriptions). ..... Uba, Merthi, CII 64 (21), Zwinga.

8. Buds germinating subapically, apex obtuse, exceeding growth ring ..... Cayania 10.
Buds germinating apically, ends usually rounded, shorter, scarcely exceeding growth ring ..... Oshima, Tekcha.

9. Ligular processes long, 2–3 cm. Stalks purple: Hybrids of *S. spontaneum* ..... 10.
Ligular processes short, less than 1 cm., or wanting. Stalks green or purple: Hybrids of *S. Barberi* ..... 11.

10. Buds small, oval, 8 × 7 mm., located 3 mm., above leaf scar .... Kassoer.
Buds semi-orbicular, 10 × 10 mm., located on the leaf scar ..... Toledo.

11. Buds oval or ovate, obtuse ..... 12.
Buds triangular-ovate, acute ..... 13.
Buds suborbicular or broader than long ..... 16.

12. Bud with wide margin, 2 mm., stalk bright, red-brown ..... CO 281.
Bud with narrow margin, 1 mm.; stalk dull, red-brown ..... CO 210.

13. Bud with the margin nearly uniform ..... POJ 213.
Bud with strongly shouldered margin ..... 14.

14. Stalks green or with a faint flush ..... POJ 234.
Stalks brown or purple ..... 15.

15. Leaf sheaths glabrous; stalks dull, brownish ..... POJ 105.
Leaf sheaths with vestiture; stalk purple ..... POJ 826.

16. Buds with a wide margin, 2 mm ..... CO 213.
Buds with a narrow margin, 1 mm ..... 17.

17. Root band narrow, 6–8 mm.; leaf scar glabrous ..... POJ 36.
Root band broad, 10 mm., leaf scar lannate ..... POJ 228.

18. (The Noble Canes, or hybrids with a large share of noble blood).
Buds lanceolate or lance-ovate, conspicuously longer than broad, usually exceeding the growth ring by one-third to one-half of their length ..... 19.
Buds oval, longer than broad, the base and apex both narrowed .. 29.
Buds ovate, usually somewhat longer than broad, the base broadly rounded, the apex narrowed ..... 32.

Buds triangular-ovate, usually about as broad as long, the base broadly rounded, the upper half triangular with straight sides.. 45.
Buds orbicular or semi-orbicular..... 56.
Buds broader than long, subquadrate..... 60.

19. Buds with the margin broader below, shouldered..... 20.
Buds with the margin uniform or nearly so..... 21.

20. Leaf scar densely ciliate; stalks purple..... T77.
Leaf scar glabrous; stalks green with red flush..... B 1809.

21. Buds with the sterile margin wide, about 2 mm..... 22.
Buds with the sterile margin narrow, 1 to 1½ mm..... 25.

22. Stalks green, with or without a flush..... 23.
Stalks purple ..... 24.

23. Internodes barrel-shaped, shouldered below; buds with moderate marginal and apical vestiture..... Ba 6032.
Internodes cylindrical; buds with heavy marginal and apical vestiture ..... SC 12(4).

24. Leaf scar ciliate..... D 95.
Leaf scar glabrous..... C 46.

25. Internodes with no bloom; *stalks slender*, less than 3 cm..... 26.
Internodes with evident bloom; stalks medium, over 3 cm..... 27.

26. Throat narrow, pallid, glaucous (two forms, solid green or striped green and yellow).....Batjan.
Throat broad, dark brown, densely lannate (= Striped tip, with green and red stripes. A solid red form, Red tip, and a green form, Yellow tip also occurs.).....Daniel Dupont.

27. Stalks dull brown, marked with black lines..... EK 28.
Stalks green with little or no flush and slight bloom..... 28.
Stalks with a pronounced flush and medium bloom..... H 109.

28. Rudimentary roots large, whitish, in 3 rows..... B 6450.
Rudimentary roots small, brownish, in 4–5 rows..... D 74.

29. Buds with a wide margin; large; stalks green..... B 306.
Buds with a narrow margin, 1 mm. or less, small..... 30.

30. Stalks green, little or no flush..... 31.
Stalks purple, heavy bloom..... D 109.

31. Leaf sheath subglabrate, but with short brown hairs..... B 1753.
Leaf sheath with a dense vestiture of pallid, sharp hairs.....Otaheite.

32. Buds with the margin wider below..... 33.
Buds with the margin uniform or nearly so..... 35.

33. Stalks dark purple, stout.....Badila.
Stalks green with a flush, slender or medium slender..... 34.

34. Buds large 12–13 × 12–13 mm., exceeding the growth ring.... B 4596.
Buds small 7 × 6 mm., not exceeding the growth ring..... SW 3.

35. Buds with a wide sterile margin, about 2 mm..... 36.
Buds with a narrow sterile margin, 1–1.5 mm..... 41.

36. Stalks green, with or without a flush..... 37.
Stalks brown or greenish brown; nodes enlarged.....Brava de Perico.
Stalks purple ..... D 99.

37. Internodes completely covered with a dense bloom..... D 433.
Internodes with little or medium bloom..... 38.

38. Growth ring brown, conspicuous; stalks stout..... PR 492.
Growth ring greenish, not conspicuous; stalks medium..... 39.

39. Leaf blades broad, 8 cm.; leaf sheaths with heavy, stiff vestiture ..... POJ 2725.
Leaf blades narrow, 5–6 cm.; leaf sheaths with scanty vestiture.... 40.

40. Ligule about 4 mm., the edge fimbriate..... B 6292.
Ligule about 3 mm., the edge even..... B 3696.

41. Ligular processes none or very poorly developed..... 42.
Ligular processes one very long, 2 cm., or more; rudimentary roots crowded, in 4 or 5 rows..... D 117.

42. Stalks green, then yellow, no flush; growth ring brown..... D 625.
Stalks green with red flush..... 43.
Stalks red or purple..... 44.

43. Buds large, 13 × 13 mm., exceeding the growth ring by one-third of length; leaf sheath with vestiture.....B 3412.
Buds small 10 × 10 mm., not exceeding growth ring; leaf sheath glabrous .....Yellow Caledonia.

44. Stalks brownish purple; leaf sheaths glabrate..... FC 306.
Stalks claret-red with bronze stripe; leaf sheaths with a dense vestiture. (Solid red. Solid bronze and white striped forms occur.) .....Cavengirie.

45. Buds with the sterile margin wider below..... 46.
Buds with the sterile margin uniform or nearly so..... 49.

46. Leaf sheaths glabrous..... 47.
Leaf sheaths with vestiture; stalks purple.....Java 51.

47. Nodes slightly enlarged; growth ring broad, purple.....POJ 979.
Nodes slightly constricted, growth ring narrow, yellowish..... 48.

48. Collar lannate; stalks green with pink flush.....Crystalina.
There is a color variant with purplish stripes.....Rayada.
A dark purple variant is.....Louisiana Purple.
Collar glaucous, not lannate; stalk green with flush..... B 376.

49. Leaf scar conspicuously ciliate; stalks green with flush..... B 3922.
Leaf scar glabrous..... 50.

50. Buds with a wide sterile margin, 2 mm..... 51.
Buds with a narrow sterile margin, 1–1.5 mm..... 54.

51. Stalks purple, rather stout..... POJ 2714.
Stalks green ..... 52.

52. Leaf sheaths with vestiture, tinged with lilac.....Penang (Porto Rico)
Leaf sheaths glabrous or glabrate, green..... 53.

53. Collar dark brown, densely lannate; ligular processes well developed ..... C 35.
Collar pallid, glaucous; ligular processes usually none..... Ba 11569.
54. Stalks green, with a brownish flush..... 55.
Stalks brownish purple..... D 1135.
55. Leaf sheaths soon glabrate, throat narrow..... Ba 12079.
Leaf sheaths with a dense vestiture, throat broad..... POJ 100.
56. Sterile margin of bud apiculate, ending in a point 3 mm. long, stalks reddish, very stout.....Elephant.
Sterile margin not apiculate, wider and shouldered below; stalks green; internodes abruptly shouldered below..... B 208.
Sterile margin uniform or nearly so..... 57.
57. Sterile margin broad, 2 mm., or more..... 58.
Sterile margin narrow, 1–1.5 mm..... 59.
58. Stalks green, no flush, no bloom..... POJ 2727.
Stalks reddish brown, no bloom..... POJ 2364.
59. Stalks green, no flush, heavy bloom.....Barbados White Sport.
Stalks green with a strong pink flush, often blotched..... BH 10(12).
60. Stalks green, no flush..... 61.
Stalks purplish ..... 62.
61. Throat and collar pallid, glaucous..... FC 137.
Throat and collar dark brown, lannate..... B 109.
62. Rudimentary roots large, in 2–3 rows..... FC 214.
Rudimentary roots small, crowded, in 4–5 rows..... D 448.

Badila.—Brought from New Guinea to Queensland as No. 15 in 1896. It is the principal commercial cane of Australia and Fiji, and is being considerably planted in various other countries.

Erect, large, heavy, but usually rather short stalks, good stools, seldom arrows. Stalks 4–5 cm., dark purple, no bloom. Internodes short, 6–8 cm., straight not staggered, larger below, groove well marked but shallow. Nodes constricted, at right angles; growth ring broad, 2.5–3 mm., at first yellowish, then concolorous or darker, swollen, the thickest part of the stalk; root band narrow, 5–7 mm., glaucous, rudimentary roots purple, scattered, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band conspicuous, about 1 cm., constricted. Bud broadly ovate, acute, about 12 x 11 mm., margin medium, nearly uniform or slightly broader below, about 1.5 mm. wide, but with a sharp, short shoulder at base; germination subapical, slightly exceeding the growth ring, basal plaes poorly developed, margins nearly glabrous but with a small apical tuft. Leaf-sheath glabrous, green or with faint purplish tinge, purple at base within, throat broad, 2 cm., dark, lannate; collar broad, poorly defined; ligule narrow, 3 mm., even; ligular processes usually only one, small, 1 cm.

Leaf blades recurved, nearly flat, broad, 7–8 cm., rather short, glaucous-green the young leaves light yellow-green, margin closely and minutely serrulate, the base ciliate.

Badila requires a moist, rather heavy soil. The tonnage is usually poor on dry lands. It often shows considerable chlorosis on lime lands. It is well adapted to clay loams and to alluvial soils. It is very rich in sucrose and very early in maturity, at the beginning of the crop showing higher sucrose even than BH 10(12). It is susceptible to mosaic but is less injured by it than some other kinds. It is markedly resistant to gum disease, leaf scald, and Fiji disease. Its considerably increased planting can be strongly recommended wherever soil conditions are suitable. It should not be planted on poor, dry lands nor on strong lime lands.

B 109.—Originated by Bovell in Barbados, of unknown parentage. At one time it was planted on a field scale in Porto Rico and probably in other parts of the West Indies. It is a thoroughly good commercial cane but has no outstanding merits and never has become widely popular.

Erect, or at length declined, stooling only moderate, arrows rather freely. Stalks long, medium stout, green, then yellowish, no flush, little or no bloom. Internodes medium length, straight or nearly so, cylindrical, furrow slight or none. Nodes not constricted; growth ring narrow, about 2 mm. somewhat elevated, concolorous; root band narrow, 6–8 mm., slightly swollen, rudimentary roots small, crowded pallid, in 2 to 3 rows; leaf scar glabrous; glaucous band well marked, not constricted. Buds obovate, broader than long with an apiculate apex, about 9 x 10 mm., not exceeding the growth ring, margin narrow, uniform, germination subdorsal, nearly glabrous but with short scanty basal places of crisped hairs and a short, scanty apical tuft from the under side of the bud. Leaf sheaths glabrous, green, but little bloom; throat with abundant vestiture of coarse hairs, densely lannate; collar broad, dark brown, reaching the midrib, densely lannate; ligule medium short, margin entire; ligular processes unequal, usually only one developed, sometimes wanting. Leaf blades spreading, rather broad, 7–8 cm., minutely but sharply serrulate, the bases ciliate.

For best growth it requires a strong loam or clay-loam soil. On such lands it will usually give rather heavier tonnage than Crystalina. On low moist soils it is likely to continue in growth and so be late in maturing, but on well-drained lands it matures about as early as Crystalina and often carries even more sucrose. It is more tolerant of mosaic than Crystalina and is usually more resistant to root dis-

ease. The only objection to its wider planting is its rather light stooling habit.

B 208.—Originated by Bovell in Barbados, of unknown parentage. It was one of the first of the Barbados seedlings to attract wide attention. It has been carried all over the world and has been tested on a field scale in most sugar-cane-growing countries. Oftentimes it has given splendid results but at other times it has failed badly. It is probably less planted now than twenty years ago, but this is largely because its soil requirements have not been understood.

Erect or at length declined, vigorous, medium to heavy stooling, seldom arrows. Stalks medium length, medium stout to stout, green, usually abruptly enlarged below at the back: furrow evident but shallow. Nodes narrow, strongly constricted; growth ring narrow, at first yellow then concolorous and inconspicuous; root band narrow, oblique, 5–8 mm., rudimentary roots in 2 to 3 rows; leaf scar glabrous; glaucous band narrow, strongly constricted, well defined. Buds subhemispheric but broader than long, about 12 x 10 mm., not exceeding the growth ring, margin narrow but distinctly shouldered at base, germination subdorsal, often developing, on the standing stalk, a scanty apical tuft of long hairs. Leaf sheaths with a dense vestiture of long, erect, pallid hairs, green or somewhat tinted, rather glaucous, stained with purple at base within; throat lannate and with an abundant vestiture of long, soft hairs; collar conspicuous, reaching the midrib, the center densely glaucous, the margins lannate with short, white hairs; ligule about 3 mm., fimbriate; ligular processes usually wanting. Leaf blades semi-erect, not numerous, broad, 8–9 cm., rather short and abruptly pointed, sharply serrulate, base a little ciliate.

This cane requires a soft and open but well-drained soil. It does not thrive on stiff clays. It is one of the best kinds to plant on reclaimed bog lands or on moist sandy-loam alluviums. Where these requirements are met it gives heavy tonnage and ratoons well. It is usually fully equal to Crystalina in sucrose and matures rather earlier. It is a very valuable cane for its special locations but it should not be planted on old, compacted clay lands. It seems to stand lime soils fairly well.

It is quite susceptible to mosaic, taking the disease readily and being badly injured by it. On suitable soils it resists root disease very well, and it seems to have some resistance to gum disease although it has not been fully tested.

B 306.—Originated by Bovell in Barbados, of unknown parentage. It is frequently found in mixed cultures in Porto Rico but is seldom

found in pure stands. It is also known in that island as B 347, but this is probably an error. It was formerly planted to some extent in other islands of the West Indies but it has never attracted much attention. Its general appearance suggests that it is a seedling of Otaheite.

Erect or at length decumbent, good vigor, medium stooling, arrows occasionally. Stalks long, medium diameter, green, yellow at maturity, no flush, little or no bloom. Internodes medium to long, slightly flattened, strongly staggered, often marked with whitish blotches, furrow slight or sometimes none. Nodes slightly constricted; growth ring narrow, slightly sunken, concolorous; root band strongly oblique, 6–10 mm., concolorous; rudimentary roots large but inconspicuous, concolorous, in about 3 rows; leaf scar at first conspicuously ciliate, later often glabrate, prominent, appressed behind; glaucous band broad, well marked. Buds large, oval, obtuse, often reddish, 10–12 x 15 mm., margin uniform rather wide, usually exceeding the growth ring, germination subapical, basal places well developed, an apical tuft and lines of hairs on the sides. Leaf sheaths with a dense vestiture of pallid hairs, green or very slightly tinted, somewhat glaucous, slightly stained purple at base within; throat dark brown, densely lannate, and with a circle of short, dark hairs behind the ligule; collar dark, rather broad, reaching the midrib, lannate; ligule medium width, about 3 mm., margin even; ligular processes none. Leaf blades numerous, somewhat two-ranked, strictly erect, plicate and revolute, bright green, 7–8 cm., very minutely serrulate, the base not ciliate.

This is a thoroughly good, medium-season, general-purpose cane but without sufficiently outstanding merits to have caused it to replace Crystalina and Rayada. On many soils it will quite certainly outyield them, and it is rather more resistant to root disease and is a better ratooner. Its soil requirements are not unlike those of Otaheite and B 208 since it prefers moist rather than dry soils. It is a little later in maturing than Crystalina but ultimately develops equally good sucrose.

B 376.—Parentage unknown, but it quite clearly must be a seedling of Crystalina, or White Transparent as it would be called in Barbados, since it resembles that variety so closely that it is almost impossible to distinguish them. No detailed description is given since it would be, word for word, the same as that for Crystalina except that in this kind the collar is usually glaucous while in Crystalina it is lannate. In cultural characters and sugar content, the two canes are practically equal. For all practical purposes this may be

considered as a rather vigorous strain of Crystalina. It is still planted on a field scale in some parts of Porto Rico.

B 1753.—Parentage unknown. It clearly belongs in the group of medium-slender canes including B 3412 and Sealey's Seedling. It is still grown on a field scale on some plantations in Porto Rico, but it is less planted than formerly, apparently on account of the widespread prejudice against slender canes. Its production record has always been good both in tonnage and sucrose. In a three-year test of twenty-four varieties at the Insular Station, it took first place in total sugar produced, averaging 4.09 tons per acre for each of the three crops.

Strictly erect, vigorous, a strong stooler, seldom arrows. Stalks medium slender, 2½–3½ cm., green, yellow when mature, no flush, no bloom. Internodes medium long, straight, cylindrical, furrow usually evident but slight. Nodes scarcely constricted; growth ring narrow, inconspicuous, concolorous; root band narrow, 6–8 mm., yellow; rudimentary roots small, indistinct, in 3–4 rows; leaf scar glabrous; glaucous band narrow, 6–7 mm., conspicuous. Buds rather small, oval-ovate with rounded narrowed base and acute point, about 8 x 10 mm., exceeding the growth ring, margin uniform, very narrow, germination apical, base, sides and apex with appressed hairs. Leaf sheaths subglabrate but with short brown hairs mixed with bloom, glaucous. Leaf blades erect, narrow, light green.

This is an unusual cane having many excellent characters. It is a little slow in germinating and is late in maturing, but when fully ripe it carries as good sucrose as Crystalina. It is quite resistant to lime-chlorosis and fairly so to root disease. Its planting can be recommended for thin lime subsoil lands. It has the reputation of resisting mosaic but this has not been fully determined. Its reaction to gum disease is not known.

B 1809.—Parentage unknown. It has been planted on a field scale in a small way in Porto Rico, and quite recently in Eastern Cuba.

Strictly erect, good vigor, medium stooling, seldom arrows. Stalks long, medium to medium-stout, green, a slight reddish flush when fully exposed, only a light bloom. Internodes rather long, a little flattened, usually abruptly shouldered below on the side opposite to the bud, furrow broad and rather deep. Nodes prominent, not constricted; growth ring broad, prominently swollen, concolorous; root band prominent, enlarged above to meet the swollen growth ring, rudimentary roots in 2–3 rows; leaf scar glabrous; glaucous band slightly constricted, well defined. Buds large, triangular-lanceolate,

acute, 12–15 x 15–20 mm., exceeding the growth ring by one-half of the length, margin narrow but shouldered, germination apical, apex bearded. Leaf sheaths with a scanty vestiture on the back, soon glabrate, green, glaucous; throat lannate, and with a medium vestiture of hairs; collar broad, dark brown, reaching the midrib, glaucous, the margins sparingly lannate; ligule medium length, margin even; ligular processes none or poorly developed. Leaf blades erect except the tips, medium width, 6–7 cm., bright green, minutely but closely serrulate to the base.

This is a good, general-purpose, medium-season cane which gives very heavy tonnage, especially on heavy, moist lands. It is not well adapted to very dry or to sandy soils. It ripens about with Crystalina and gives equally good sucrose throughout the season. It is about equally susceptible to mosaic but resists root disease better on poorly drained lands. Where soil conditions are favorable, it will give decidedly heavier tonnage than Crystalina. Its planting can be recommended for low, heavy lands.

B 3412.—A seedling of D 74 which was originated by Bovell in Barbados. This cane has been quite widely planted in Porto Rico and is now being grown to some extent in Eastern Cuba. The canes grown in Porto Rico as B 3405 and Sealey's Seedling can scarcely be distinguished from this one and, judging from rather inadequate published descriptions,[2] they are probably mislabeled and really all belong here.

Erect or at length decumbent, vigorous, free stooling, arrowing only in certain localities. Stalks long, medium-slender, usually 2.5 to 3 cm., sometimes thicker, green with a strong reddish flush when fully exposed, bloom light but usually evident. Internodes medium to long, often slightly staggered, compressed laterally, furrow well marked. Nodes slightly constricted, oblique; growth ring inconspicuous, usually slightly sunken, 2 to 3 mm. wide, concolorous; root band oblique, 6 to 10 mm., concolorous, rudimentary roots slightly sunken, inconspicuous with a very small purplish center, in 3 to 4 rows; leaf scar glabrous, appressed behind; glacous band conspicuous, 8–10 mm., scarcely constricted. Buds rather large, ovate, rather obtuse, about 13 x 13 mm., exceeding the growth ring by one-third of length, margin broader below but not shouldered, 1 to 1.5 mm., germination apical, the base with places of heavy crisped hairs, margin and apex bearded. Leaf sheaths with heavy vestiture of short, stiff assurgent hairs, green, not, or but little, glaucous; throat lannate and with long hairs behind the ligule; collar broad, rather conspicuous, glaucous

[2] Sugar Cane Exp. in Leeward Islands, etc., 1918–19, pp. 4–5.

or sometimes lannate; ligule 3 to 4 mm. at center, tapering to 1 mm. at ends, the edge fimbriate; ligular processes none. Leaf blades spreading, more or less in two ranks, crowded, narrow, usually averaging but little more than 5 cm., bright green, minutely but sharply serrulate, the base nearly even, scarcely ciliate.

This is a vigorous, strong-ratooning cane which gives heavy tonnage under most soil conditions. It is late in maturing and gives very poor sucrose until fully ripe, when the yield is satisfactory, often fully as good as Crystalina though at the beginning of the crop it may not have been half as good. It is a cane that holds over well to the second year. Spring-planted cane should always be held over as "caña quedada." It has been quite widely planted in Porto Rico, but usually on uplands, since on low, moist lands, while the tonnage is very heavy, it is difficult ever to mature it properly. Besides its late maturing, another drawback is the tendency of the buds to sprout prematurely and develop aerial suckers. Its chief advantages are its vigor, high tonnage, resistance to root disease, and unusually good ratooning power.

It does not take mosaic quite as freely as some other kinds, but when attacked it is much dwarfed and very seriously injured. It is also often heavily attacked by leaf spots. It is said to have great resistance to lime chlorosis. Its reaction to gum disease has not been determined.

B 3696.—Parentage not known, but it clearly belongs in the group with B 1753 and B 3412. The bud characters and general appearance are very similar. It is grown on a plantation scale at a few places in Porto Rico where it has a good record for vigor and sugar yields per acre.

Erect, seldom decumbent, good vigor, free stooling, strong ratooning, seldom arrows. Stalks long, medium to medium-slender in diameter, dull green with a red flush where exposed, medium bloom. Internodes medium to long, laterally compressed, somewhat inequilateral, the front straight and the back somewhat convex, conspicuously staggered, furrow well developed. Nodes but little constricted, oblique; growth ring medium width, slightly depressed, bright green; root band oblique, 6 to 8 mm., slightly elevated, concolorous, rudimentary roots crowded, small, inconspicuous, in 3 or 4 rows; leaf scar glabrous, appressed behind; glaucous band well marked, slightly constricted. Buds ovate, obtuse, 12 x 15 mm., exceeding the growth ring by one-half, margin rather broad, uniform, germination apical, basal plaes and a marginal vestiture of white hairs. Leaf sheaths with sparse vestiture of short hairs, soon glabrate, green, not glaucous;

throat lannate and with tufts of long hairs at the margins; collar narrow, not reaching the midrib, glaucous, the margins lannate; ligule about 3 mm., the margin even; ligular processes small, poorly developed. Leaf blades spreading, flat, rather narrow, about 6 cm., light green; very minutely serrulate, the base even, not ciliate.

This is a good, high-tonnage commercial cane that can be recommended for general planting on lands where kinds like Crystalina begin to fail. It has not been as widely planted as B 3412 but it is a better cane. The buds do not sprout on the standing cane, and while it is late in maturing it is not as late as the latter kind and finally develops even better sucrose, as shown by the record of a car ground at Central Vannina, Porto Rico, on June 11, 1920, which gave Brix 22.2, sucrose, 20.35, purity 91.67. It was sold on the basis of sucrose content and brought the grower the phenomenal return of 9.89 per cent in sugar on the weight of cane.

It can be carried over for the second crop more safely than Crystalina and should not be cut under fifteen to eighteen months.

This cane is very resistant to root disease. It is susceptible to mosaic, suffering about as severely as Crystalina. Its behavior with gum disease is not known.

B 3922.—A seedling from B 647. Until the mosaic outbreak it was planted largely on the south side of Porto Rico in the irrigated district. Being very susceptible to that disease, it practically went out of cultivation. Now that mosaic is more or less under control there, it is again being planted. It is one of the few of the older varieties that is competing with BH 10(12) and SC 12(4).

Erect but at length declined, a good stooler, seldom arrows. Stalks long, medium diameter, green with a reddish flush, light bloom. Internodes medium to long, nearly cylindrical but a little flattened, sometimes shouldered below, straight or a little staggered, sometimes marked with lines; furrow slight but evident. Nodes slightly constricted, oblique; growth ring poorly defined, often purplish; root band oblique, narrow, 5–8 mm., concolorous, rudimentary roots small, crowded, in about 3 rows; leaf scar conspicuously ciliate with white, erect hairs about 3 mm. long; glaucous band well marked, about 8 mm., somewhat constricted. Buds usually tinted, broadly triangular-ovate, obtuse, often broader than long, 10–12 x 10 mm., slightly exceeding the growth ring, margin of medium width, uniform, germination apical or subapical, with basal places of crisped hairs and a scanty marginal vestiture. Leaf sheaths with short scanty vestiture, green, little or no bloom; throat narrow, pallid, sparingly lannate, and with a circle of scattered rather stout hairs behind the ligule,

especially on the margins; collar narrow, pallid, scarcely reaching the midrib, minutely lannate; ligule about 3 mm., minutely fimbriate; ligular processes none or poorly developed. Leaf blades spreading or half erect, about 6 cm., light green, minutely serrulate, the base scantily ciliate.

On suitable lands this is a high-tonnage cane. It is later than Crystalina but at full maturity gives equally good sucrose. It has not been tested widely enough fully to determine its soil requirements but it will probably give best results on rather moist, black lands. It ratoons well and seems fairly resistant to root disease. As previously stated, it is susceptible to mosaic and should only be planted where this disease is being controlled.

B 4596.—A seedling of B 521. It has been planted on a field scale in Porto Rico and in the British West Indies.

Erect or at length decumbent, vigorous, a free stooler, arrows frequently. Stalks long, medium to medium-slender in diameter, green with a dull reddish flush, usually checking in lines, little bloom. Internodes medium length, flattened, slightly tumid, nearly straight, furrow fairly well marked. Nodes constricted, oblique; growth ring narrow, inconspicuous, even, concolorous; root band narrow, oblique, 5–8 mm., bright green; rudimentary roots large, yellowish, crowded, in 2–3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, 7–8 mm., sharply constricted, conspicuous. Buds large, broadly ovate, obtuse, 12–13 x 12–13 mm., exceeding the growth ring, margin broad, 2 mm. or more, slightly shouldered, germination subapical, nearly glabrous, apical and marginal hairs short and scanty. Leaf sheaths glabrous, green, glaucous; throat lannate and with a sparing vestiture of medium hairs on the margins; collar broad, pallid, reaching the midrib, glaucous, the margins lannate; ligule about 4 mm., the margin undulate and slightly fimbriate; ligular processes none. Leaf blades spreading, abundant, flat, somewhat 2-ranked, 6 cm., light green, minutely serrulate the base even, not ciliate.

This kind is resistant to root disease and makes heavy tonnage on wet compacted lands where Crystalina begins to fail, but it is not adapted to dry lands. At one time it was supposed to be resistant to mosaic but this is not the case. It is very late in maturing and is usually very low in sucrose, being comparable to Cavengirie in this respect. It is included here so that it may be recognized and its planting avoided. There are plenty of other varieties that will yield as good or better tonnage on low, heavy lands and that are far better as sugar producers.

B 6292.—A seedling of T 24. It has been grown on a field scale in Porto Rico.

Erect or tardily decumbent, vigorous, a good stooler, arrows occasionally. Stalks long, medium to medium-slender, green with dull-red flush, little bloom. Internodes medium length, somewhat compressed, inequilateral, slightly tumid on side opposite bud, furrow shallow but evident. Nodes slightly constricted, oblique; growth ring medium width, often slightly elevated, greenish; root band oblique, 6–10 mm., greenish; rudimentary roots crowded, whitish, in 3 to 4 rows; leaf scar glabrous, appressed behind; glaucous band slightly constricted, 9–10 mm., well marked. Buds broadly ovate, obtuse, sometimes broader than long, about 13 x 14 mm., exceeding the growth ring by one-third, margin broad, 2 mm., uniform, germination apical or subapical, usually soon developing on the standing stalks, with heavy basal places of crisped hairs and abundant marginal and apical vestiture. Leaf sheaths with scanty but long and coarse vestiture, green or sometimes a little tinted below, not glaucous; throat often crinkled, lannate, and with scanty marginal hairs; collar reddish brown, glaucous, the margins lannate; ligule about 4 mm., the edge uneven and fimbriate; ligular processes none or small and poorly developed. Leaf blades abundant, flat spreading, 5–6 cm., light green, minutely serrulate, the base even, not ciliate.

This is a valuable kind for low, wet, heavy lands where it will give fully as good tonnage as Yellow Caledonia, and it is a much better milling and sucrose cane. It is late in maturing but when fully ripe it will yield as much and often more sugar than Crystalina.

It is susceptible to mosaic and is about like Crystalina in resistance to root disease. It should not be planted on dry hill lands.

B 6450.—A seedling of T 24. This cane has been planted quite widely in different parts of the West Indies. At one time it was the leading commercial cane in Barbados but it has been largely superseded there by BH 10(12) and other of the newer kinds.

Soon decumbent, vigorous, stools well, arrows infrequently. Stalks long, medium diameter, green, yellow when ripe, little or no flush, often checking in lines, some bloom. Internodes medium to long, somewhat tumid, usually larger below, more or less staggered, furrow broad but shallow. Nodes constricted, oblique; growth ring broad, elevated, concolorous; root band oblique, 6–10 mm., concolorous, rudimentary roots large, closely crowded, whitish, in about 3 rows; leaf scar glabrous appressed behind; glaucous band constricted, narrow, 6–8 mm., well marked. Buds large, lance-ovate, acute, 11–12 x 16–18 mm., exceeding the growth ring by one-half or more, margin narrow,

uniform, germination apical, basal place short and rather scanty with a scanty marginal vestiture of long hairs. Leaf sheaths with a scanty vestiture of short appressed hairs, green or slightly tinted below, not glaucous; throat narrow, lannate, with scanty marginal hairs; collar narrow, pallid, glaucous, the margins lannate; ligule broad at center, reaching 5 mm., the ends tapering rapidly, fimbriate; ligular processes absent or poorly developed. Leaf blades abundant, flat, suberect, 6–6.5 cm. wide, bright, rather dark green, minutely serrulate to the base, scarcely ciliate.

This is a good general-purpose cane, succeeding on a variety of soils but rather better adapted to low, black lands. It is often slow in germinating but when once established it ratoons well and shows considerable resistance to root disease. It is susceptible to mosaic but shows some degree of tolerance, being rather less injured than Crystalina. It is mid-season in maturing, ripening about with Crystalina and usually developing about equally good sucrose. Like so many others, it is a good cane but not superlatively good, and has been largely superseded.

BA 6032.—Planted commercially in Barbados and to a limited extent in Porto Rico.

Soon reclined, medium stools, seldom arrows. Stalks medium to medium-stout, green, no flush, little bloom, marked with irregular brownish lines. Internodes medium length, strongly staggered, barrel-shaped, enlarged and shouldered below, furrow none. Nodes strongly constricted, oblique; growth ring about 3 mm. wide, even, sometimes brownish, often obscure; root band narrow, 5–8 mm., constricted, concolorous, rudimentary roots large, scattered, centers brownish, in 2 to 3 irregular rows; leaf scar glabrous, narrow; glaucous band constricted, about 8 mm. wide, fairly well defined. Buds large, thick, prominent, lanceolate or lance-ovate, about 15 x 10 mm., exceeding the growth ring by one-third or more, germination subapical, margin wide, uniform, basal place heavy, of tawny hairs extending up the veins, marginal and apical vestiture scanty, of long tawny hairs. Leaf sheaths with rough vestiture along the median portion, soon glabrate, green, glaucous, stained purple at base within; throat narrow, brownish, poorly defined, the margins lannate with dark hairs, the center glaucous, heavily ciliate at the margins behind the ligule, no long hairs in center; ligule 1–4 mm., margin undulate, not fimbriate; collar pallid, poorly defined, hardly reaching the midrib, glaucous, the margins scarcely lannate; ligular processes short, broadly triangular. Leaf blades suberect, broad, 6–7 cm., dull, dark green, margin scarcely serrulate, the bases ciliate.

This is a rich sucrose cane but seems to require moist, rich lands and good cultivation. In Porto Rico it proves to be susceptible to gum disease. In Barbados average yields for eight crops are reported as 31.76 tons per acre as against 20.45 tons for Crystalina.

BA 11569.—This is one of the various series of seedlings produced in Barbados. At present it is being more planted in that island than any other variety, reports stating that 90 per cent of the new plantings in 1926 were of this kind. It is also a strong favorite in Guadeloupe where it is reported as being particularly adapted to dry lands and very high in sucrose and purity.

Erect, at length prostrate, good stools, makes cane early. Stalks medium to medium-stout in diameter, green, no flush, little bloom, often marked with irregular brownish lines. Internodes medium length, cylindrical but conspicuously enlarged below, staggered, no furrow. Nodes constricted below the bud; growth ring broad, 3–4 mm., elevated, conspicuous, often brownish, the thickest part of the stalk; root band 8–10 mm., tapering downward, subconcolorous, rudimentary roots large, rather obscure, crowded, in 3–4 rows; leaf scar broad and heavy below the bud, appressed behind, glabrous; glaucous band broad, 1 cm., constricted, well marked. Buds large, thick, prominent, triangular-ovate, reaching but hardly exceeding the growth ring about 12 x 12 mm., germination subapical, margin broad, nearly uniform, basal places well developed of pallid hairs, margins and apex nearly smooth but a short tuft under the germinating point (not the sterile apex). Leaf sheaths at first with stiff hairs along the median portion, at length glabrate, green, somewhat glaucous; throat narrow, pallid, glaucous, the margins lannate and ciliate with long pallid hairs, stiff pallid hairs behind the ligule, especially near the center; collar narrow, pallid, reaching the midrib, glaucous, the margins faintly lannate; ligule narrow, evenly rounded, 1–3 mm., the edge even; ligular processes none, or reduced to an angular point. Leaf blades erect except the tips, 5–6 cm. wide, channeled, 2-ranked, dull green, the margins minutely serrulate, the base scantily ciliate.

This kind has not been fully tested in Cuba and Porto Rico where so far it has probably attracted less attention than it deserves, partly because there has been some difficulty in securing good germination. Any variety that can supplant BH 10(12) in Barbados and Guadeloupe, as this has done, is certainly worthy of serious consideration.

BA 12079.—This kind does not seem to have been much planted on a commercial scale, but in experimental plots it is making a good showing and seems worthy of commercial planting.

Erect, good stools, good vigor. Stalks medium diameter, green

with a brownish flush when exposed and more or less marked with whitish blotches, scanty bloom. Internodes medium length, somewhat staggered, cylindrical or somewhat barrel-shaped, furrow none. Nodes constricted, oblique; growth ring narrow, 2–3 mm., elevated, often brownish; root band narrow, 5–7 mm., pallid, rudimentary roots small, whitish, indistinct, in about 3 rows; leaf scar glabrous, narrow, appressed; glaucous band constricted, narrow, about 7 mm., well marked. Buds short, triangular-ovate, often subquadrate, about 10 x 10 mm., exceeding the growth ring by one-fourth or less, germination subapical, margin narrow, even or slightly shouldered, basal places of whitish hairs, margins and apex subglabrous. Leaf sheaths with vestiture on the median line, soon glabrate, green, glaucous; throat narrow, brown-lannate, ciliate at margins only; collar narrow, reaching the midrib, brownish, glaucous, not lannate; ligule narrow, 1–3 mm., margin even; ligular processes none. Leaf blades erect except the tips, dark green, sharply serrulate, the bases ciliate.

It seems to stand drought unusually well, and the few analyses available indicate good quality and fairly early maturity.

BH 10(12).—A seedling of B 6835. At present one of the most widely planted varieties in all parts of the West Indies where it is rapidly replacing Crystalina. This and SC 12(4) are by far the two most popular kinds.

Erect or at length declined, vigorous, a strong stooler and good ratooner, seldom arrows. Stalks long, medium or medium-slender, greenish but soon flushing to a uniform dull pink, marked with lines and often with conspicuous whitish blotches, considerable bloom. Internodes medium length, staggered, somewhat compressed, larger below, often shouldered opposite the bud. Nodes constricted, oblique; growth ring rather broad but indistinct, enlarged on the shoulder behind; root band oblique, 6–10 mm., concolorous but paler, tapering downward, rudimentary roots small, purplish, in 3 or 4 rows; leaf scar glabrous, appressed behind; glaucous band slightly constricted, about 8 mm., somewhat obscured by the bloom of the internode. Buds nearly orbicular, 10–11 x 10–11 mm., only slightly exceeding the growth ring, margin narrow, uniform, often purplish, germination subapical, with basal places, and sparse marginal and apical vestiture. Leaf sheaths with a sparse vestiture of short, appressed hairs, green or slightly tinted, somewhat glaucous; throat narrow, lannate, with a sparse marginal vestiture of long hairs; collar narrow, scarcely reaching the midrib, glaucous; ligule about 3 mm., margin undulate, not fimbriate; ligular processes small and poorly developed or none. Leaf blades suberect, the tips declined, flat, about 6 cm. wide, widest

above the middle, light green, minutely serrulate, the base even, not ciliate.

This cane is fully deserving of its great popularity. It is a prompt and strong germinator, a rapid grower, heavy stooler, and strong ratooner. It is adapted to a wide variety of soils and on any reasonably good land will give a heavier tonnage than Crystalina. It responds liberally to heavy fertilization and good cultivation. Although not as showy a cane as SC 12(4), its chief competitor, it is usually a better germinator and on most soils yields as good tonnage. Its outstanding merit, however, is its very high sucrose content and purity. It matures in midseason, about with Crystalina, but remains in best condition longer. Many long series of analyses from different localities indicate that it will average about 2 per cent higher in sucrose than Crystalina and about 1 per cent higher than SC 12(4) under the same conditions. Unfortunately, it is susceptible to mosaic and this disease must be kept under strong control in order to plant it successfully. This is being done on an island-wide scale in Porto Rico, and the large proportion of this cane now planted there is an important factor in the astonishing increase in sugar production on that island during the past two or three crops. It is fairly resistant to root disease but it occasionally fails badly on poor lands. In some locations it is attacked by Helminthosporium leaf spot. Inoculation experiments reported by Matz indicate that it has considerable resistance to gum disease.

From every point of view, it must be considered as among the few very best cane varieties of the world.

Barbados White Sport.—A cane under the name of White Sport was mentioned in the Barbados Report for 1905–7, p. 34. It nowhere seems to have been cultivated extensively, but it has been largely used by Mr. R. M. Gray in his breeding work at the Harvard Botanical Garden at Central Soledad, Cuba. It figures in the parentage of many of his best varieties, some of which show a combination of vigor, drought resistance, and high sucrose content that seems certain to bring them into general cultivation.

Erect, good vigor and stooling. Stalks long, medium to medium-stout in diameter, about 3–3.5 cm., green, no flush, heavy bloom. Internodes long, 10–12 cm., cylindrical to barrel-shaped, somewhat staggered, no furrow. Nodes constricted, oblique; growth ring 2–3 mm., even, dark brown, conspicuous; root band strongly constricted, 9–11 mm., concolorous but with no bloom, rudimentary roots crowded, yellowish with brown centers, in about 4 rows; leaf scar glabrous, narrow, appressed behind; glaucous band 8–10 cm., obscured by the

bloom of the internode. Buds suborbicular, about 10 x 10 mm., not reaching the growth ring, reddish brown, margin narrow, 1 mm., uniform, germination subapical, basal places of short hairs but extending up the sides nearly to germination point, a lateral vestiture of long assurgent hairs from below the margin, ending in a pronounced apical tuft. Leaf sheaths with a scanty, stiff, mostly deciduous vestiture, pale green, slightly glaucous, not tinted at base within; throat broad, dark, crustose, sparingly lannate, no long hairs behind the ligule; collar scarcely reaching the midrib, pallid, the middle smoky brown, glaucous, and minutely lannate; ligule about 4 mm., the edge nearly even; ligular processes short, 1 cm., obtuse. Leaf blades half erect, broad, 6–7 cm., dark green, sharply serrulate, the base scantily ciliate.

But little is known of the cultural characters of this variety. Its cross-bred seedlings show great vigor and drought resistance, combined with high sucrose content. The seedling Hrv. 12029, produced in 1921 by crossing White Sport on Crystalina, is particularly noteworthy and is being planted on a commercial scale.

Batjan.—This name appears only in the Javan literature. There is a solid green and a striped green and bright yellow form. It does not figure among the varieties that are being planted commercially in Java at the present time, but it is being used in breeding work. POJ 2727 is a seedling of Batjan crossed with POJ 2364.

Erect, vigorous, heavy stools. Stalks medium to medium-slender, solid green, no flush, no bloom. (Bright yellow with bright green stripes in the striped form.) Internodes medium length, cylindrical or slightly larger below, straight or slightly staggered, furrow slight but extending the entire length of the internode. Nodes not constricted; growth ring medium width, slightly elevated, subconcolorous; root band rather broad, pallid, or concolorous, rudimentary roots pallid, distant, in 3 or 4 rows; leaf scar glabrous, narrow, appressed behind; glaucous band very narrow, about 5 mm., well marked. Bud lanceolate, acute, about 12 x 6 mm., exceeding the growth ring by one-third of its length, margin narrow, uniform, germination apical, vestiture scanty. Leaf sheaths glabrous, only slightly glaucous, the striped form with indistinct whitish stripings; throat narrow, pallid, glaucous, with tufts of long pallid hairs at the margins; collar narrow, pallid, reaching and including the midrib, glaucous, the margins minutely lannate; ligule uniformly rounded, 2–4 mm., the margin fimbriate; ligular processes, one well developed, slender. Leaf blades suberect, narrow, 4 to 4.5 cm., dark green, minutely serrulate, the bases ciliate.

The scanty data available indicate a medium or medium late-maturing cane, but with good sucrose at maturity. It is a vigorous-growing high-tonnage cane apparently adapted to medium and poor soils.

Brava de Perico.—This is one of the old cane varieties that is occasionally admixed with Crystalina in Cuba, particularly in Matanzas province. It was also formerly called Burra though that name is now locally applied to another cane. Its true name has not been determined. It is nowhere being intentionally cultivated except in experimental plots, but it is evidently a good ratooner or it would not have survived for all of these years.

Erect, good vigor, heavy stooler, seldom arrows. Stalks medium diameter, 3–3.5 cm., brownish or brownish-green, darker on exposure, no flush, bloom none or very slight. Internodes rather long, 10–13 cm., cylindrical, furrow none or very slight. Nodes enlarged, the thickest part of the stalk; growth ring narrow, 2 mm., concolorous on the margins but with a central brownish circle 1 mm. or less broad, somewhat elevated; root band 10 mm. wide below the bud but narrower behind, concolorous but paler, rudimentary roots rather scattered, large, whitish with purple centers, in 2 to 3 irregular rows; leaf scar narrow, glabrous, appressed; glaucous band conspicuous, 10 mm. broad. Buds large, prominent, ovate-apiculate, exceeding the growth ring by one-fourth of its length, margin uniform, or slightly wider below, broad, about 2 mm., reddish, germination subapical, basal places of crisped hairs ample and extending well up on the sides, marginal hairs and apical tuft short. Leaf sheaths with vestiture of short hairs, green, somewhat glaucous, no purple stain within; throat broad, 1.5–2 cm., dark brown, densely lannate and with a vestiture of long hairs; collar broad, reaching 3 cm. at the margin and extending to the midrib, dark brown, densely lannate and with places of white hairs; ligule narrow, 2–3 mm., the edge ciliate; ligular processes none. Leaf blades spreading, flat 7–8 cm. wide, yellow-green, margin minutely serrulate, almost even, base ciliate with tufts of long whitish hairs.

Recent experimental work indicates that it is especially well adapted to the thin, black soils with a lime subsoil where many varieties show chlorosis. It is holding its own well on other soil types, but it clearly prefers a heavy, rather than a light, soil. It is a rich, fairly early-maturing cane. At the Baragua Experiment Station, Cuba, on red land on 3/24–27 at 17 2/3 months, it gave Brix 22.99, Suc. in juice 21.62, Purity 94.04 and stood first, in sucrose out of 240 hand-mill analyses made at this time. With such a record it

is clearly worth continued study and a further effort to determine its true name.

Cavengirie.—This is one of the older varieties and under one name or another it has been widely planted in many parts of the world (for synonyms see annotated list, p. 266) It is still the cane principally planted in Brazil, and this accounts in large part for the low sugar yields usually reported from that country. It has been considerably planted in Porto Rico and Cuba, especially in the poorer lands where the Crystalina and Rayada canes begin to fail.

Erect, very vigorous, a strong stooler, seldom (or in most countries never) arrows. Stalks medium diameter, tall, dark wine-red with usually one faint bronze stripe, no bloom. Internodes medium to long, straight or slightly staggered, cylindrical or slightly larger below, furrow faint, usually evident below, but sometimes wanting. Nodes narrow, only slightly constricted; growth ring conspicuous, usually swollen, at first yellowish then dark purple; root band narrow, 6–8 mm., concolorous, rudimentary roots inconspicuous, purplish, in 2–3 rows; leaf scar glabrous, narrow, somewhat oblique; glaucous band narrow 6–8 mm., at first well marked. Buds ovate, medium size, about 10–12 x 10–12 mm., slightly exceeding the growth ring, margin narrow, uniform, germination apical, the base sparingly appressed ciliate, the sides and apex glabrous. Leaf sheaths with a dense vestiture of short assurgent bristles, tinted, somewhat glaucous, marked with white or sometimes white and pink stripes; throat lannate, and with abundant short, brownish hairs, especially on the margins; collar broad, dark, conspicuous, densely lannate at least toward the margins; ligule narrow 3–3.5 mm., margin nearly even; ligular processes none. Leaf blades erect, the tips declined, dark green, medium width, about 6 cm., minutely but sharply serrulate to the base, not ciliate.

A number of well-marked color variants exist, some of which have been given special names and have been somewhat widely planted. A form with white striping on the leaves is not uncommon. Cavengirie Roja (also called Rosita and Sangre de Toro) is uniformly wine-colored and lacks the white stripes on the sheath. Cavengirie Negra is dark reddish brown, almost bronze, throughout and without stripes on the sheaths. It has been considerably planted in Porto Rico and probably also in Queensland under the name of Cheribon. Cavengirie Rayada has light green instead of bronze stripes. All of these forms closely resemble the type in cultural characters.

It is a hardy cane, growing well and giving good tonnage on poor, dry lands where the Preanger canes begin to fail. Unfortunately,

it is very susceptible to mosaic, taking the disease freely and being injured by it more severely than most other kinds. It has some considerable resistance to gum disease, which is the reason for its having superseded Otaheite in Brazil, but is not completely immune. It is very late in maturing and, especially when planted mixed with other kinds, it is usually cut before it has much value as a sugar producer.

In fact, it is one of the few kinds that seldom ripen sufficiently to yield satisfactory sucrose. Since there are now plenty of other equally hardy canes known that will produce equal or better tonnage on poor lands and that will make far better sugar yields, there seems to be no possible reason for continuing to plant Cavengirie. Mills should absolutely prohibit its planting.

Cayania 10.—This cane is supposed to have originated at the extinct experiment station in French Guiana. It was imported to the United States from Bahia, Brazil, in 1914, by the Department of Agriculture, and is now quite widely planted in Louisiana, Georgia, and Florida, for syrup making. Some of it has been ground for sugar in Louisiana. It is of the *Saccharum sinense* type, very closely resembling Uba in appearance and cultural characters.

Erect, very vigorous, a strong stooler, arrows, but rather less frequently than Uba and Kavangire. Stalks long, slender, usually 1.75–2.5 cm., green with faint lilac flush where exposed, considerable bloom. Internodes long, often reaching 15 cm., tapering, slightly larger below, furrow usually none. Nodes conspicuously enlarged; growth ring about 2 mm., even or slightly sunken, greenish; root band conspicuously enlarged, 10–12 mm., wide, green or tinted, rudimentary roots large, crowded, the centers brown, in about 3 rows; glaucous band about 10 mm., poorly defined, tapering sharply, the base being the narrowest part of the stalk; leaf scar at first with a circlet of hairs below the bud, but soon glabrate. Bud ovate, plump, rather obtuse, about 10 x 12–14 mm., at first not exceeding the growth ring but often soon developing, margin medium width, 1.5 mm., uniform, germination subdorsal, base glabrate, sides and apex with long appressed hairs. Leaf sheaths with a scanty vestiture of short hairs which are more abundant toward the margins, green, scarcely glaucous; throat sparingly lannate, no long hairs except scanty tufts at the margins; collar narrow, inconspicuous, not reaching the midrib, glaucous, not lannate; ligule broad with a triangular widening at center where it reaches 5 mm., the margin fimbriate; ligular processes none. Leaf blades spreading, flat, narrow, about 4.5 to 5 cm., dark green, minutely but sharply serrulate to the base, not ciliate.

The canes of this group resemble each other so closely that it is difficult to find diagnostic characters by which to separate them. In this cane the stalks are less tinted and the leaf sheaths adhere more closely than in the true Uba, and the buds germinate subdorsally, not apically. The leaf sheaths have more vestiture and the nodes are more enlarged than in Kavangire. It is a very vigorous cane, giving high tonnage even on poor lands, and it is immune to mosaic, but it is very late in maturing and usually develops less sucrose than either Uba, CH 64(21), or Kavangire. There seems to be no reason for planting it in preference to these other kinds of the same type. Its present somewhat wide planting in the southern United States seems to be due to the accident of its earlier introduction rather than to superior merit.

CO 210.—This is one of the hybrids produced by Barber at the Coimbatore Breeding Station in India. It is a seedling of POJ 213. The male parent is not known but it is probably some local Madras seedling.

It is being extensively planted in many parts of India where it is very largely outyielding the older native kinds both in tonnage and in sugar. It seems to be especially adapted to hard, dry lands but it also resists water-logging.

Erect, great vigor, a heavy stooler, ratoons strongly, usually arrows but little. Canes long, slender, 2–2.5 cm., dull reddish brown, medium bloom. Internodes medium to long, straight, not staggered, cylindrical, furrow faint or none, but usually evident. Nodes nearly even or slightly enlarged, not oblique; growth ring 3 mm. or wider, even, concolorous; root band narrow, 5–7 mm., somewhat enlarged, pallid to concolorous, rudimentary roots large but obscure, in 2 rows; leaf scar glabrous, narrow, appressed behind; glaucous band poorly defined, usually slightly constricted. Bud flat, ovate, apex obtusely rounded, rather small, about 9 x 10 mm., margin narrow, uniform, about 1 mm., exceeding the growth ring by one-fourth to one-third of its length, germination subapical, nearly glabrous, basal places greatly reduced and marginal and apical vestiture rudimentary. Leaf sheaths glabrous, green; throat narrow, glaucous, the margins sparingly lannate and with scanty marginal hairs; collar narrow, pallid, glaucous; ligule broad, 4 mm. or more, conspicuously fimbriate; ligular processes greatly reduced. Leaf blades fairly erect, flat, narrow, 3–4 cm., light green, margin weakly and distantly serrulate, the base ciliate.

It has not been extended on a field scale in Cuba but has been planted experimentally to a sufficient extent to show that in tonnage it is about equal to Uba and that it will probably resist extreme

drought conditions better, but that it is usually lower in sucrose. It has also been shown that this cane takes mosaic readily and seems to be considerably dwarfed and injured by it. This was not expected on account of its parentage, but this character, together with its slender diameter, is likely to prevent it from being commercially planted. The next number, CO 213, is decidedly more promising.

CO 213.—This, like the last, is a seedling of POJ 213, the male parent being either Kansar or Madras 2. It, too, is being extensively planted in India where it is a heavy yielder, showing great drought resistance and also ability to withstand water-logging.

Erect, very vigorous, very heavy stools, strong ratooner, arrows frequently. Stalks long, medium-slender, 2.5–3 cm., reddish brown, heavy bloom. Internodes medium to long, subcylindrical but slightly enlarged below on side opposite the bud, almost shouldered, furrow none. Nodes slightly constricted, somewhat oblique; growth ring narrow, 2–3 mm., nearly even or slightly constricted, pallid, then brown, often edged with purple above; root band narrow, oblique, 5–7 mm., pallid, then brown, even or slightly constricted, rudimentary roots large with purple centers, in 2 and usually a broken third row; leaf scar glabrous, appressed behind; glaucous band narrow, 6–8 mm., constricted, rather poorly defined. Buds flat, suborbicular, about 10 x 10 mm., margin broad, 2 mm., nearly uniform but often a short point like a shoulder below, not exceeding the growth ring, germination dorsal, nearly glabrate but with evident basal places of soft, closely felted hairs and very scanty marginal and apical vestiture. Leaf sheaths with a short, scanty vestiture, slightly tinted, glaucous; throat smooth (not wrinkled), pallid, the margins scantily lannate with short white hairs; collar poorly marked, pallid, glaucous; ligule rounded, 4 mm., fimbriate; ligular processes none or poorly developed. Leaf blades suberect, narrow, 4–5 cm., light green, minutely but closely serrulate, the base ciliate.

In Cuba it is proving to be very resistant on hard, dry, rocky soils and will probably outyield any variety so far tried under these extreme conditions. It is late in maturing but when fully ripe it sweetens up well. It is susceptible to mosaic but seems to be even more tolerant than its POJ parent. It is also very resistant to root-disease troubles. Everything considered, it is one of the most promising of the *Saccharum Barberi* canes and it deserves to be widely planted wherever conditions are severe enough to indicate the use of this race of canes. Its hardiness to cold has not been tested but will doubtless be found to be good.

CO 281.—A seedling of POJ 213, crossed with CO 206 which is a seedling of Ashy Mauritius.

Erect, vigorous, heavy stools, arrows freely (peduncles and midribs glabrous). Stalks medium-slender, 2–3 cm., dark reddish brown, medium bloom. Internodes long, cylindrical, furrow none. Nodes even, neither oblique nor constricted; growth ring broad, 4 mm. or more, even, pallid, at length purplish; root band broad, 8–10 mm., even, or slightly enlarged, pallid, at length concolorous, rudimentary roots large, whitish, in 3 rows; leaf scar glabrous, somewhat appressed behind; glaucous band, 10 mm., slightly constricted, well defined. Buds oval, about 10 x 12 mm., plump, margin broad, 2 mm., broader below, reaching or slightly exceeding the growth ring, germination subdorsal, nearly glabrous. Leaf sheaths glabrate, glaucous, tinted, soon deciduous, leaving the stalk clean; throat brownish, glaucous, the margins lannate, no long hairs; collar narrow, strongly whitened, glaucous; ligule broad, 4 mm., fimbriate; ligular processes poorly developed or none. Leaf blades nearly erect, about 4 cm. wide, dull green, minutely serrulate, the base scantily ciliate.

This really remarkable cane seems to have attracted no attention in India, but in Cuba it is proving to be one of the richest in sucrose and earliest in maturity of all the many kinds under observation, being equaled in these respects only by the Badila, first one and then the other of these canes taking first place in all of the early-season analyses. It is usually late in March before even so rich a cane as BH 10(12) overtakes them.

It is being extensively planted, especially in the older red lands in Cuba where Crystalina begins to fail. It is perhaps hardly as resistant to extreme drought as CO 213, but under any reasonable soil conditions it makes big tonnages and the juices are so rich, especially early in the season, that sugar per acre yields promise to be very large. The trash sheds so freely and the cane is so clean that its comparatively slender diameter will not be especially objectionable in harvesting.

It is susceptible to mosaic but seems to be fairly tolerant. It is very hardy and resistant to all root troubles.

Its early maturity indicates that it may have very especial value for subtropical climates, where it is proving even more resistant to cold than any of the POJ series.

Creole.—The first and, for over two hundred years, the only cane planted in America. It is supposed to have been brought to Southern Europe from Palestine by the Crusaders but to have originally come

from India. The cane still planted there as Puri is identical.[3] It has also been identified as the Yellow Egyptian of the Java collections. In America it was quickly and completely superseded as a commercial cane by the Otaheite in the early days of the nineteenth century and is now only occasionally seen in gardens where it is still sometimes planted for chewing.

Erect, moderate growth, arrows occasionally. Stalks slender, rather short, green with a slight purplish flush when fully exposed, scanty bloom. Internodes medium to short, about 2.5 cm., in diameter, cylindrical, straight or slightly staggered, furrow shallow but well marked for entire length of internodes. Nodes slightly constricted, somewhat oblique; growth ring narrow, inconspicuous, concolorous root band narrow, oblique, 5–8 mm. wide, rudimentary roots inconspicuous, in about 3 rows; leaf scar glabrous or with a few short, scattered cilia, narrow; glaucous band slightly constricted, 8–10 mm., conspicuously whitened when young, no circlet of hairs below the bud. Buds narrowly ovate-triangular, about 8–10 mm., exceeding the growth ring, margin narrow, slightly wider below but not shouldered, germination apical, glabrate or nearly so. Leaf sheaths at first with a soft vestiture, then glabrate, green, faintly glaucous; throat dark, lannate with medium-long hairs toward the margins; ligule widest at center, reaching 4 mm., the ends tapering, margin nearly even; ligular processes none; collar narrow, reaching the midrib, glaucous, sparingly lannate at the margins. Leaf blades erect or sometimes the tips declined, somewhat plicate, narrow 3–4.5 cm., light green, serrulate with long awned teeth, the base somewhat ciliate.

It has no possible commercial value since the tonnage is small and the juices only moderately good in sucrose. It is quite susceptible to mosaic. As the tissue is soft, it was easily crushed by the mills of the early days of the sugar industry.

Crystalina.—This is one of the most widely planted commercial canes and is to-day making a larger proportion of the world's sugar than any other variety. The entire industries of Cuba and Santo Domingo are based on it and it is still widely planted in some parts of Porto Rico. It is the Rose Bamboo of Hawaii and the White Transparent of the British West Indies.

Erect, then usually recumbent, vigorous, a good stooler, arrows freely at some times and on some soils but under other conditions seldom arrows. Stalks medium diameter, green, usually with a strong

[3] See Noel Deerr, Int. Sugar Jour., Jan., 1928, p. 11, as in the West Indies, it is now planted only for eating.

pink flush where exposed, yellowish at maturity, heavy bloom, the color varies greatly on different soils and under different conditions of growth. Internodes medium length, cylindrical or somewhat tumid, straight or slightly staggered, furrow evident, of medium depth. Nodes oblique, somewhat constricted; growth ring yellowish green, conspicuous, elevated; root band narrow, oblique, slightly constricted, concolorous, rudimentary roots small, inconspicuous, pallid, with brownish centers, in about 3 rows; leaf scar glabrous, wide in front, appressed behind; glaucous band constricted, rather narrow, not very conspicuous, blending with the bloom of the internode. Buds medium size, flat, triangular-ovate with rounded base, exceeding the growth ring, margin wide, conspicuously wider and shouldered below, germination apical, well-developed basal places of crisped hairs which extend up to the margin, and a pronounced apical tuft but no marginal vestiture. Leaf sheath glabrous, greenish, quite glaucous; throat densely lannate and with abundant long, coarse hairs; collar conspicuous, reaching the midrib, lannate throughout; ligule medium width, margin even; ligular processes usually one well developed, about 1 cm. Leaf blades abundant, spreading, flat, medium width and length, about 7 cm. broad, bright green, minutely serrulate, the base conspicuously ciliate, often for 5–8 cm.

This is clearly one of the best of the old standard canes. Since the failure of the Otaheite it has been more widely planted than any other kind. It is adapted to an unusually wide range of soil and cultural conditions and gives very large yields where these conditions are favorable. There are few varieties which respond more readily to better cultivation, higher fertilization, and irrigation. However, on old compacted lands and with lack of proper tillage it is beginning to fail and it is in many regions being rapidly replaced by other kinds that are better able to resist unfavorable conditions. It is a good germinator and an unusually strong ratooner. It is about mid-season in maturity but develops some sucrose early, before it is really ripe. When fully mature it is a fine free-milling cane of the best type. Its juices are unusually high in purity although there are a number among the newer kinds that will give a higher percentage of sucrose. Unfortunately, it is susceptible to mosaic and also to gum disease although it takes the latter less freely than Otaheite. Its planting can still be confidently recommended for all good lands, but it should be replaced on the poorer soils by other kinds, and it should always be supplemented by other kinds to grind at the beginning and the end of the crop. It is impossible that any one kind should be in the best condition for all parts of a six to eight months' grinding season.

Even on the best lands, BH 10(12) and SC 12(4) will yield more sugar per acre.

The above description applies to the light form. There are two other color variants, the Striped or Ribbon cane of Mexico and Louisiana, called Rayada or Cinta in Spanish-speaking countries, and the Louisiana Purple or Morada. Both of these have been extensively planted in many countries. They are indistinguishable except in color and seem to have identical cultural characteristics.

Planters usually have a strong prejudice in favor of one or the other of these color mutants, but if any other characters are really correlated with these color changes the fact has not yet been demonstrated by carefully controlled experimentation. It is a problem well worthy of critical study.

These canes have long been considered to be the Cheribon canes of Java. Dr. Jeswiet of Java, however, on his recent visit to Cuba, positively identified Crystalina as the Light Preanger and not the Light Cheribon. Both occur in Java in all their color forms and they are so similar that they were confused by the earlier writers of Java. They were first distinguished by Dr. Jeswiet by slight differences in the vestiture of the buds, the Cheribon canes having a short marginal vestiture of dark hair which is lacking in Preanger. Apparently, none of the true Cheribon series have been introduced in America.

C 35.—This cane was bred at the Cuban Experiment Station in 1915, by T. H. Lougher. It is a seedling from the cane there known as "D 74," which is not that kind but some undetermined, late-maturing heavy-tonnage, green kind. It was called "Super-Crystalina" by Dr. Calvino, at one time Director of the Cuban Station. It has attracted more attention than any of the other Cuban seedlings and has been planted on a field scale in various parts of the island.

Erect, tall, good vigor, fair stooling, seldom arrows. Stalks long, medium to medium-stout, green, yellowish at maturity, no flush, medium bloom. Internodes long, 10–15 cm., slightly staggered, cylindrical or sometimes swollen behind, furrow none. Nodes about even or a little constricted; growth ring narrow, 2 mm., even, brownish; root band 1 cm. wide at bud but narrowed behind, pallid, rudimentary roots inconspicuous, pallid, in about 3 rows; leaf scar glabrous, prominent under the bud, appressed behind; glaucous band broad but indistinct. Buds triangular-ovate to subquadrate, rather plump, about 12 x 12 mm., margin broad, nearly uniform, not exceeding the growth ring, germination subdorsal, basal plaes poorly developed but with a pronounced apical tuft of hairs. Leaf sheaths glabrous, green, glaucous; throat narrow, 8 mm., dark brown, densely lannate; collar

narrow, dark brown, densely short lannate; ligule wide, 3–5 mm., edge lacerate; ligular processes one strongly developed, 10–12 mm., curved. Leaf blades strictly erect except the tips, narrow, 5–6 cm., deeply channeled, margins subrevolute, dark green, minutely serrulate, base ciliate.

It is a heavy-tonnage, late-maturing cane that usually runs rather low in sucrose. It is, too, very susceptible to mosaic. There is nothing to indicate that it will ever be widely planted. SC 12(4) is adapted to the same soils and will usually give even heavier tonnage and very decidedly better sucrose.

C 46.—Parentage unknown. It is planted on a field scale in a limited way in Cuba.

Erect, vigorous, good stooler, arrows freely. Stalks tall, medium diameter, about 3.5 cm., dark purple, brown at maturity, some bloom. Internodes medium length, 9–13 cm., subcylindrical, furrow slight but evident. Nodes broad, not constricted; growth ring broad but poorly defined, 4–5 mm., greenish; root band broad above the bud, narrowed behind, 7–8 to 10–11 mm., pallid, at length concolorous, rudimentary roots crowded in 4–6 irregular rows, pallid with dark centers, at length concolorous; leaf scar glabrous, broad, prominent in front, appressed behind, strongly oblique; glaucous band 8–10 mm., poorly defined. Buds large, flat, broadly lanceolate, 14 x 20 mm., exceeding the growth ring by half their length, margin uniform, medium broad, germination apical, heavy basal plaes extending well up on the sides, a marginal vestiture of long brown hairs ending in a long, broad, apical tuft. Leaf sheaths glabrous, green, scarcely glaucous; throat medium broad, pallid, with brown lannate vestiture; collar 12 mm. wide, reaching and discoloring the midrib, pallid, sparingly lannate on margins; ligule narrow, uniform in width, about 3 mm., the edge ciliate; ligular processes none. Leaf blades suberect but tips declined, nearly flat, 6–7 cm., dark green, minutely serrulate, base even, not ciliate.

This is probably a more useful cane than the last, being adapted to poorer soils. It thrives fairly well in sandy "sabana" lands and seems to be particularly adapted to shallow lime-subsoils. It is a good ratooner and develops fairly good sucrose. So far, it is scarcely planted commercially.

CH 64(21).—Bred at the Cuban Experiment Station at Santiago de las Vegas in 1921. It is said to be a hybrid from Uba as pistillate and "D 74" as staminate parent. The so-called "D 74" of this station is not true to name but is an undetermined late-maturing green cane. The seedling resembles Uba so closely in every particular

that its hybridity is very doubtful. It would seem to be of pure *Saccharum sinense* blood, and while very close to Uba its cultural characters are slightly different. It is being planted to some extent on a field scale in Cuba.

Erect, very vigorous, an enormous stooler, arrows, but less freely than Uba. Stalks very long, slender, 2.15 to 2.50 cm., late suckers usually larger, often reaching 3 to 3.25 cm., green, with reddish-lilac flush when exposed, medium bloom. Internodes long, 10–13 cm., cylindrical, straight, not staggered, channel none. Nodes enlarged, scarcely if at all oblique; growth ring about 3 mm., nearly even, the upper half hardly distinguishable, pallid brownish; root band abruptly enlarged, about 10 mm. but narrower behind, pallid, glaucous or waxy, rudimentary roots distant, concolorous, in 3 usually interrupted rows; leaf scar glabrous, circlet of hairs below the bud soon deciduous, appressed behind, the widest part of the stalk; glaucous band tapering sharply downward, about 10 mm., fairly well defined. Bud ovate, large, 10–12 x 12–14 mm., plump, subacute, margin uniform or broadest at the middle, 1–1.5 mm., the apex obtusely rounded, exceeding the growth ring by one-fourth to one-third of length, germination apical, basal plaes short and scanty, marginal vestiture of long, appressed pallid hairs, apical tuft scanty. Leaf sheaths glabrate but with short, scanty vestiture along the median line, green, somewhat glaucous, stained purple at the base within; throat narrow, nearly plane, at first minutely lannate, then glabrate or crustose, no long hairs except the sparingly ciliate margins; collar pallid, reaching the midrib, glaucous, not lannate; ligule with the ends narrow, about 2 mm., but the middle abruptly widened to 5 mm., greenish, the margin at first minutely fimbriate, at length even and lacerate; ligular processes none. Leaf blades spreading, long, 1.25 m. or more, fairly broad, 4–5.5 cm., medium bright green, the margins minutely but sharply serrulate, the base scantily ciliate.

This kind is clearly distinct from Uba but it is very difficult to find technical characters by which to distinguish them. CII 64(21) averages a little thicker stalks than Uba; it clears itself of trash a little better; it arrows less freely; and the buds sprout less easily on the standing cane. They are equally late in maturing but in a series of analyses it will average a little better sucrose than Uba. It is equally immune to mosaic and to the different forms of root disease. Everything considered, it is the best of the *Saccharum sinense* canes, at least under Cuban conditions, and it should be planted where canes of this class are needed.

Daniel Dupont.—(= Striped Tip).—At one time this cane was

considerably planted in Mauritius and in Queensland. Mr. Moir of Hawaii, who saw it in experimental plots in Cuba, identifies it as the Striped Tip of Hawaii, which is still planted extensively there on the highest of the hill lands. In Cuba it has been known only in the variety collections at Central Soledad where Mr. Gray has used it as a parent in some of his cross-bred seedlings.

Erect, very good vigor and stooling. Stalks long, medium slender, 2.5–3 cm., greenish brown with dark red stripes, no bloom. Internodes cylindrical but often somewhat larger below, straight not staggered, medium long, 10–12 cm., furrow faint but usually evident. Nodes even, not constricted; growth ring about 4 mm., even, pallid; root band somewhat oblique, 10–12 mm., pallid, at length subconcolorous, rudimentary roots large, scattered, pallid with pale brown centers, in about 4 broken rows; leaf scar glabrous, appressed behind; glaucous band narrow, 6–8 mm., well marked. Buds lance-ovate, acute, 10–12 x 14 mm., slightly exceeding the growth ring, margin uniform, narrow, about 1 mm., germination apical, nearly glabrous, basal places greatly reduced, margins slightly lannate, no apical tuft, marked with red lines along the nerves. Leaf sheaths at first with a whitish vestiture, soon glabrate, green but usually somewhat tinted, slightly glaucous, faintly tinted with purple at base within; throat broad, dark brown, densely lannate, no long hairs; collar pallid, reaching the midrib, glaucous; ligule broad, 3–5 mm., the edge undulate but not fimbriate; ligular processes usually one developed, narrow, 1 cm. or more long, often wanting. Leaf blades erect except the tips, narrow, 5 to 5.5 cm. wide, somewhat channeled, the margins even, not serrulate, the base with scanty, often soon deciduous cilia.

Solid-colored sports occur. These are the Red Tip and the Yellow Tip of Hawaii. Both have appeared in Mr. Gray's cultures at Central Soledad, the red sport in 1904, and the yellow in 1905.

This is a vigorous cane, yielding good tonnage, but it is reputed to be rather low in sucrose. It is probably late in maturing, but we lack exact data. It is adapted to growth at high altitudes, but we know little about its soil requirements. The red sport is said to stand drought better than the yellow and striped forms. It is very susceptible to mosaic and suffers severely when attacked. On the other hand, it is said to be resistant or immune to gum disease.

D 74.—A seedling of White Transparent. Like D 95 and other early Demerara seedlings, it was really bred in Barbados and taken to Demerara when quite small.

On account of its early maturity, this has for many years been one of the principal commercial canes of Louisiana. It has also been

planted to some extent in Mauritius and it has been tried in an experimental way in all sugar-cane-growing countries. On account of its susceptibility to mosaic, it is rapidly being replaced in Louisiana by POJ 234. The variety somewhat extensively distributed in Cuba under this name is not D 74 but some undetermined late-maturing kind somewhat closely resembling B 109 but probably not that variety.

Erect, good vigor, good stooling, arrows freely. Stalks medium diameter, about 3.5 cm., green, no flush, faint bloom. Internodes somewhat staggered, cylindrical or slightly enlarged below, furrow faint but usually evident. Nodes somewhat constricted, slightly oblique; growth ring about 2 mm., indistinct, even; root band broad 10–13 mm., oblique, pallid, rudimentary roots small, brownish, closely crowded, in 4 or 5 rows; glaucous band indistinct, somewhat constricted, about 10 mm.; leaf scar glabrous, prominent in front, appressed behind. Buds broadly lanceolate to ovate-acuminate, 10 x 15 mm., exceeding the growth ring by one-fourth of length, margin narrow, 1.5 mm., uniform, germination apical, subglabrous but with short apical tuft of hairs. Leaf sheath nearly glabrous, green, not glaucous, no tinge of purple at base within; throat broad, 15 mm., lannate, blackish; collar broad, glaucous, the margins lannate; ligule narrow at the ends, 2 mm., abruptly widened to 5 mm., at center, margin crenulate; ligular processes none. Leaf blades erect except the tips, dark bluish green, 5 cm., midrib channeled, margin sharply serrulate, the base sparingly ciliate.

This cane is about equal to Crystalina in tonnage and in sucrose content but it matures from a month to six weeks earlier, often showing as much as 2 per cent more sucrose at the beginning of the crop. This early maturity is its chief advantage. In this it is exceeded by Badila which develops higher sucrose even earlier in the season. Its susceptibility to mosaic is probably no greater than that of Crystalina but has caused it to fail disastrously in Louisiana, where, it must be confessed, no effective measures have been taken to control this disease. It seems doubtful if D 74 will ever regain its lost popularity. When plantation managers come to recognize the advantage of having some fields of early-maturing kinds on which to begin grinding, then D 74 will have to be carefully considered for a place among them.

D 95.—It is said that this is a seedling of White Transparent (= Crystalina), and that, together with D 74 and some other of the early Demerara numbers, it was really bred at Barbados but was taken to Demerara as a small pot-grown seedling at the time that Sir John B. Harrison was transferred from that island where he had

been working jointly with Mr. John Bovell in the early cane-breeding work. It was included with D 74 in the first importation of Demerara canes into Louisiana and has been in continuous cultivation there since that time though it has never been as popular as D 74. On account of the ravages of mosaic, this and all the rest of the straight noble canes are on the point of being entirely discarded. At one time it was planted to some extent in Porto Rico. In 1911 it took first place in total sugar per acre with a record of 7.84 tons, but for some unknown reason it has completely disappeared there.

Erect or at length prostrate, good vigor and stooling, usually arrows less freely than D 74. Stalks medium length and diameter, about 3 cm., dull purple, heavy bloom, internodes long, 10 cm. or more, cylindrical but larger below, often with an abrupt shoulder opposite the bud (as in B 208), not staggered, furrow slight but usually evident. Nodes constricted, only slightly oblique; growth ring broad, 4–5 mm., nearly even, dark purple; root band about 10 mm., constricted, pallid, soon concolorous, rudimentary roots crowded, with dark centers, in about 4 rows; leaf scar ciliate, appressed behind; glaucous band narrow, obscured by the bloom of the internode. Buds lance-ovate, acute, about 12 x 14 mm., exceeding the growth ring by one-third to one-half of its length, margin broad, 2 mm., nearly uniform, germination apical, basal plaes well developed, a scanty marginal vestiture and a pronounced apical tuft of tawny hairs. Leaf sheaths with a scanty vestiture of long lax hairs, green, somewhat tinted, little bloom, not tinted at base within; throat broad, discolored, crustose, sparingly lannate, no long hairs behind the ligule; collar broad, reaching the midrib, brown, minutely lannate; ligule 3–4 mm., minutely fimbriate; ligular processes short, broadly triangular, often wanting. Leaf blades erect except the tips, broad, 7–8 cm., bright but dark green, minutely serrulate, the base sparingly ciliate.

This is a good early-maturing high-sucrose cane. There seems to be no reason why it should not have been more widely planted. Like all the rest of the straight noble canes of which we have any knowledge, it is susceptible to mosaic and this will prevent it from being widely planted. Resistance or tolerance to mosaic is rapidly becoming a first requisite for commercial canes.

D 99.—The really good qualities of this cane seem to have been overlooked. It has nowhere been planted commercially on a large scale. It has been considerably used as a parent in the breeding work at the Cuban Experiment Station, a number of the Cuban seedlings being of this parentage.

Erect, vigorous, good stooler, ratoons well, arrows freely. Stalks

medium diameter, averaging slightly thinner than Crystalina, brownish purple, heavy bloom. Internodes long, cylindrical, straight, not staggered, no furrow. Nodes not constricted; growth ring broad, 3 mm., even, pallid or at length concolorous; root band broad, 1 cm. or more, pallid but blotched with purple, rudimentary roots large, crowded, whitish, in about 4 rows; leaf scar glabrous, prominent on side below the bud; glaucous band obscured by the heavy bloom. Buds large, ovate, exceeding the growth ring by one-third of its length, margin broad, uniform, germination apical, basal plate poorly developed, subglabrous, margins subglabrous, apical tuft heavy. Leaf sheaths glabrous, somewhat glaucous, green or the base slightly tinted; throat broad, pallid, subglabrous; collar broad, reaching and including the midrib, pallid, subglabrous; ligule broad, thin, pallid, lacerate; ligular processes none. Leaf blades erect except the tips, flat, 5–6 cm. wide, dark green, margins minutely serrulate, the base heavily ciliate.

This is a good general-purpose cane, maturing a little earlier than Crystalina and usually showing equally good tonnage and sucrose. It is adapted to rather lighter and poorer soils than Crystalina. It is about equally susceptible to mosaic.

D 109.—This kind has been planted quite extensively on the North Coast of Porto Rico. It has been widely distributed in other cane-growing countries but does not seem to be widely planted commercially elsewhere.

Usually soon decumbent, good vigor and stooling, arrows freely. Stalks long, medium diameter, purplish red, fading to brownish red at maturity, heavy bloom. Internodes medium to long, somewhat barrel-shaped or subcylindrical and enlarged below, furrow shallow, often wanting. Nodes strongly constricted; growth ring broad, usually 4–6 mm., even or nearly so, at first yellowish, then dark purple or brownish purple; root band narrow, 6–7 mm., strongly constricted, at first yellowish but at length darker than the internodes, rudimentary roots small, crowded, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, 6–7 mm., constricted. Buds small, oval-ovate, obtuse, 8–9 x 8–9 mm., exceeding the root band but seldom exceeding the growth ring, margin very narrow, germination apical, inconspicuous basal plate and scanty marginal and apical vestiture, sometimes subglabrate. Leaf sheaths with a short scanty vestiture which is usually deciduous, leaving the mature sheath glabrate, strongly tinted, glaucous; throat lannate, with scanty vestiture of long hairs on the margins; collar well marked, reaching the midrib, often with purplish tints, glaucous or the margins sparingly lannate;

ligule short, 2–3 mm, nearly even; ligular processes irregular or wanting, sometimes one developed. Leaf blades spreading, flat, about 6 cm., rather dark green, the midrib sometimes purplish with age, minutely serrulate, the base even and sparingly ciliate.

This is a good general-purpose cane adapted to about the same soils and cultural conditions as Crystalina. Usually it seems a little hardier and better able to withstand unfavorable conditions. It is equally susceptible to mosaic and it is a little later in maturing, although usually developing equally good sucrose when fully ripened. It may succeed in some locations where Crystalina is failing but it is hardly likely to replace that variety widely. It often suffers seriously from Helminthosporium eye spot.

D 117.—A seedling of White Transparent (= Crystalina). Before the mosaic outbreak this was one of the principal commercial canes on the south coast of Porto Rico. A yield of 9 tons of sugar per acre has been reported by Central Rufino. At one time a little of it was planted in Hawaii, but it does not seem to have attracted attention in other localities. The following description and discussion is based on material from Porto Rico. This was introduced by the Mayaguez Station in 1904 from Audubon Park, Louisiana, and as this was imported directly from Demerara in 1893 it presumably represents the true variety. The material distributed by the Cuban Station is a different though somewhat similar cane. (It has recently been recognized by Mr. Moir as the Yellow Bamboo of Hawaii.)

Strictly erect, good vigor and stooling, arrows freely on some soils. Stalks long, medium diameter, green, yellowish when ripe, flush none or very slight, little or no bloom. Internodes medium to long, straight or slightly staggered, cylindrical or sometimes larger below, furrow slight or none. Nodes scarcely constricted, somewhat oblique; growth ring narrow, brownish, prominent, the widest part of the stalk; root band oblique, 8–10 mm., light green, tapering downward; rudimentary roots small, crowded in 4 or 5 rows; leaf scar glabrous, appressed behind; glaucous band slightly constricted, about 8 mm., conspicuous. Buds large, ovate, obtuse, about 14 x 14 mm., exceeding the growth ring by one-fourth, margin narrow, uniform, germination apical or subapical, often developing on the standing cane, basal places short and scanty, short marginal and apical vestiture. Leaf sheaths with scanty, short, appressed vestiture, often becoming nearly glabrate, green, somewhat glaucous, stained purple at base within; throat densely lannate and with a conspicuous vestiture of long hairs on the margins and behind the ligule; collar conspicuous, dark brown, reach-

ing the midrib, lannate on the margins; ligule short, 2–3 mm., nearly even; ligular processes unequal, one usually strongly developed, often 2 cm. or more long, acute, the other often wanting. Leaf blades suberect, crowded, flat, somewhat 2-ranked, dark green, 6–7 cm. wide, very minutely serrulate, the base even, not ciliate.

Among the numerous green canes with large ovate buds, this is easily distinguished by the small, crowded 4 or more ranked rudimentary roots and the unusually long ligular processes.

It is a good, vigorous, general-purpose cane but is particularly adapted to low, heavy lands where it will produce exceptionally heavy tonnages. It seems to have some special ability to withstand salty soils and should always be tried where this trouble exists. It is decidedly later in maturing than Crystalina, but when fully ripe it develops fully as good sucrose. It is said to ratoon poorly in Hawaii but it is a good ratooner in the West Indies where it usually shows fairly good resistance to root disease, especially when this is caused by compacted soils. It is as susceptible to mosaic as Crystalina but is usually injured somewhat less when attacked. It deserves a place among the first-class standard varieties.

D 433.—For some years this has been the principal commercial cane in the Fajardo District of eastern Porto Rico. It does not seem to be extensively planted elsewhere.

Erect, or at length declined, good vigor and stooling, seldom arrows. Stalks long, medium to medium stout, green, sometimes with a slight pink flush, completely covered by a dense gray bloom (hence the local name of Cenisia or Ashy cane). Internodes long, cylindrical or somewhat enlarged below, staggered, furrow none. Nodes constricted, oblique; growth ring narrow, even or a little sunken, greenish; rootband about 8 mm., concolorous, rudimentary roots large but indistinct, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band almost completely obscured by the heavy bloom of the internodes. Buds broadly ovate, obtuse, 12 to 14 x 12 to 14 mm., exceeding the growth ring by one-fourth, margin medium width, uniform, germination subdorsal, basal pacs short, marginal vestiture heavy, ending in a pronounced apical tuft and extending down the back of the bud to the germinating point. Leaf sheaths with a moderate vestiture of long, stiff assurgent hairs, greenish, densely glaucous; throat lannate and with a sparse vestiture of long hairs on the margins and behind the ligule; collar narrow, reaching the midrib, pallid, glaucous, slightly lannate on the margins; ligule about 3 mm., the margin fimbriate; ligular processes none. Leaf blades

erect, the tips declined, broad, flat, or the margins slightly revolute, reaching 8 cm. or more, dull bluish green, serrulate to the sparingly ciliate base.

The soil on which this cane has done so well locally in Porto Rico is a rather compact, yellow clay loam where Crystalina frequently fails from root disease. Here D 433 grows well, ratoons well, and gives very heavy tonnage. It is late in maturing but at full maturity gives nearly as good sucrose as Crystalina. It is susceptible to mosaic but is usually less injured by it than is Crystalina. Its success at Fajardo has led to its extensive trial in other parts of Porto Rico but it has nowhere else come into general planting.

D 448.—This cane has been planted commercially in the Fajardo district of Porto Rico, but it is not being extended there as it is not well adapted to those compact yellow clay soils. A considerable planting of it, under the name Caña Japonesa has been found in central Cuba.

Erect, or at length decumbent, good vigor and stooling, arrows frequently. Stalks long, medium-stout, dull purple, fading to dirty brown on maturity, heavy bloom. Internodes medium length, straight or nearly so, cylindrical or somewhat enlarged below, furrow none. Nodes scarcely constricted, somewhat oblique; growth ring broad, a little sunken, greenish or yellowish; root band 8–10 mm., greenish, rudimentary roots small, obscure, purplish, crowded in 4 or 5 rows; leaf scar glabrous, appressed behind; glaucous band 8–10 mm., scarcely constricted, not conspicuous. Buds large, broader than long, obtuse, plump, about 14–15 x 12 mm., not exceeding the growth ring, margin narrow, uniform, germination dorsal, basal places moderate, marginal vestiture of medium length, hairs and lines of short, white, appressed hairs along all the vascular bundles of the bud scales. Leaf sheaths with a short, scanty, appressed vestiture when young, usually glabrate with age, glaucous, strongly tinted; throat lannate, and with a vestiture of rather short whitish hairs; collar reaching the midrib, pallid, lannate with short white hairs; ligule 3–4 mm., even; ligular processes none. Leaf blades suberect, the tips drooping, flat, about 7 cm. wide, medium dull green, serrulate to the base, not ciliate.

This cane often gives very big tonnage but it seems to require a somewhat open, porous soil. It is a midseason cane and gives satisfactory sucrose, and it is hard to see why it has not been more widely planted. In Cuba it is also found under the number D 216. It seems to be one of those very good canes that still require further testing.

D 625.—Bred by Sir John Harrison in Demerara. It is a seedling from Dyer, which in turn was a seedling of Meligeli. It is still the principal commercial cane of Demerara, in 1923 constituting 71 per cent of the total acreage. It is considerably grown in Porto Rico but usually only in mixed plantings.

Erect, or at length prostrate, very vigorous, a strong stooler, arrows freely. Stalks long, medium-stout, green then yellow, no flush, little or no bloom. Internodes medium-long, cylindrical, straight or nearly so, furrow slight or none. Nodes not constricted; growth ring broad, 3–6 mm., elevated, brownish, usually very conspicuous; root band narrow, 6–8 mm., whitish, then concolorous, rudimentary roots large, scattered, in about 3 rows. Leaf scar sparingly ciliate, often becoming glabrate, appressed behind; glaucous band narrow, about 8 mm., well marked. Buds broadly ovate, about 12 x 12 mm., scarcely exceeding the growth ring, margin narrow, uniform, germination apical, basal plaes heavy, marginal vestiture and apical tuft abundant, of long, brownish hairs. Leaf sheaths glabrate, green, glaucous, purple at base within; throat narrow, pale brown, densely lannate; collar narrow, not reaching the midrib, pale brown, glaucous; ligule broad, 5–6 mm., margin even; ligular processes usually reduced to an angular lobe, often none. Leaf blades spreading, 6–7 cm. wide, dull green, minutely but sharply serrulate, the base nearly even and sparingly ciliate.

On good soils this cane often gives very heavy tonnage. It is rather late in maturing and it is poor in sucrose until fully mature, which often gives it a bad reputation. At one time its planting was prohibited by the mills in Porto Rico, although when fully ripe it develops almost as good sucrose as Crystalina. In Demerara its sugar content is considered satisfactory and as good as the Otaheite which it has replaced. Notwithstanding its great vigor, it sometimes develops root disease and it is badly injured by mosaic. It is quite resistant to gum disease. As in the case of so many other really good varieties, it is not probable that its planting will ever be greatly extended. In Porto Rico it is also known as D 116, but this is an error.

D 1135.—At the present time this cane is being more largely planted in Hawaii than any other kind except H 109. It is mostly planted at higher elevations than the latter and on poorer and non-irrigated lands. It is coming into notice in many other countries but usually for planting on the poorer classes of lands.

Erect, usually medium growth, good stools, seldom arrows. Stalks medium to medium-slender in diameter, about 3 cm., dark brownish purple, little or no bloom. Internodes medium length, straight or

slightly staggered, cylindrical, furrow well marked for entire length of internode. Nodes not constricted, oblique; growth ring medium width, 3 mm., even, at first pallid, then concolorous or darker; root band narrow, 7–8 mm. in front about 5 mm. behind, pallid, at length concolorous, rudimentary roots crowded, purplish, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, about 6 mm., obscure, poorly marked. Buds ovate-triangular 8 x 10 mm., hardly exceeding the growth ring, margin narrow, uniform, germination apical, subglabrous but with a weak apical tuft. Leaf sheaths with a short vestiture of whitish hairs on the back, often tinted purplish, somewhat glaucous, faintly stained with purple at the base within; throat narrow, 6 mm., brownish, glaucous, minutely lannate at the margins; collar narrow, reaching the midrib, glaucous; ligule 3 mm. broad, even; ligular processes none. Leaf blades erect almost to the tips, narrow, 4–5 cm., dark green, sharply serrulate, the base ciliate.

This cane is a particularly good germinator and seems to be a strong ratooner. It grows well on rather poor lands, but the tonnage is only moderate and it is very late in maturing and usually conspicuously poor in sucrose, although an occasional analysis shows up fairly well. It is hard to understand its apparent popularity for it is susceptible to mosaic and on these poorer lands where it is generally planted it will not yield nearly as much, either in tonnage or sucrose, as the immune Uba. On such lands, too, it is far outyielded by the susceptible but tolerant Coimbatore canes, CO 210 and CO 213, and in most such soils it will also give less tonnage than the slender POJ canes. It seems to be more nearly comparable with Cavengirie both in fair tonnage yields on poor soils and in poor sucrose content. With so many better poor-land canes to choose from, there seems to be no reason for continuing to plant it.

Elephant.—(= Gigante). Erect, late, continuing long in growth, seldom or never arrows. Stalks soft and very brittle, medium-tall, very stout, 5 cm. or more in diameter, dull purple, very heavy bloom. Internodes short, 5–8 cm., nearly straight, cylindrical or the shorter ones barrel-shaped, furrow none. Nodes scarcely constricted, not oblique; growth ring narrow, concolorous, a little sunken, being usually the narrowest part of the stalk; root band about 10 mm., concolorous, rudimentary roots obscure, in about 4 rows; leaf scar glabrous, short, appressed behind; glaucous band obscured by the heavy bloom of the internodes. Buds hemispheric, about 11 mm., the margin abruptly widened at the middle where it forms an obtuse, sterile apex fully 3 mm. long, an exceedingly conspicuous diagnostic character,

exceeding the growth ring only by this sterile apex, germination dorsal, nearly glabrate except for basal places of short appressed hairs. Leaf sheaths with a heavy vestiture of stiff assurgent hairs, usually splitting down the back, strongly pouched below the bud, green or somewhat tinted, heavily glaucous, stained purple within; throat very wide, glaucous, usually with transverse checks, glabrate except for scattered hairs on the margins; collar very wide, conspicuous, reaching the midrib, heavily glaucous, not lannate; ligule short, 2–3 mm., even; ligular processes none. Leaf blades long, spreading, somewhat revolute, very wide, 7.5–9 cm., gray-green, minutely serrulate, the base slightly ciliate.

This cane often figures in the literature and it is often planted as a curiosity. It probably has no commercial value. While the stalks are conspicuously large and heavy the tonnage is not great and the juice is poor in sucrose. Then, too, the soft brittle stalks would be difficult to mill.

EK 28.—One of a series of seedlings bred by E. Karthans in Java. It is a cross between EK 2 and POJ 100. EK 2 was a cross between Red Fiji and Lahaina, while POJ 100 is Black Borneo crossed with Loethers. This is now the principal commercial cane of Java, producing about half the sugar made there.[4] It has been extensively used in the recent breeding work of the Java Station, POJ 2714, 2725, 2878 and others, being seedlings of EK 28.

Erect, good vigor and stooling, arrows frequently. Stalks long, medium to medium-stout, 3–3.5 cm., green, turning dull brownish on exposure, marked with black lines, medium bloom. Internodes rather long, often 10–13 cm., cylindrical, straight, furrow slight. Internodes not constricted, not oblique; growth ring narrow, 2 mm. or less, somewhat sunken, concolorous or brownish; root band narrow, 10 mm. in front, 7 mm. at back, pallid, rudimentary roots scattered, pallid, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band poorly defined. Buds ovate-lanceolate, about 10 x 15 mm., exceeding the growth ring by one-third to one-half, margin narrow, uniform, germination apical, with well-developed basal places, marginal vestiture and apical tuft (resembling Otaheite). Leaf sheath glabrous and glaucous, no purple tint at base within; throat broad, blackish, lannate; collar broad, reaching the midrib, pallid, glaucous, scarcely lannate; ligule broad, reaching 6 mm. at center, ends narrowed to 3 mm., margin fimbriate; ligular processes none or poorly developed.

[4] Since the above was written, EK 28 is being rapidly replaced in Java by POJ 2878, one of its seedlings but carrying one-fourth of Kassoer blood.

Leaf blades spreading, 5–6 cm., dark green, sharply serrulate, the base ciliate.

It seems to be a good general-purpose cane, thriving fairly well on a variety of soils, but has not been sufficiently tested in the West Indies really to determine its value. It matures about with Crystalina, develops about the same sucrose, and is about equally susceptible to mosaic. On the whole, it is making a rather better showing than H 109.

FC 137.—Bred at Central Fajardo, Porto Rico, and planted there on a field scale.

Erect, at length prostrate, only medium stools. Stalks long, medium-stout, green, yellow when ripe, no flush, medium bloom. Internodes medium long, 10 cm. or more, cylindrical to barrel-shaped, somewhat staggered, furrow slight or none. Nodes constricted, somewhat oblique; growth ring medium broad, 3–4 mm., elevated, usually brownish, conspicuous; root band broad, 10–12 mm., concolorous, tapering below, rudimentary roots medium size, crowded, green with brown centers, in 4–5 rows; leaf scar glabrous, narrow, appressed behind. Buds obtuse, broader than long, 10 x 8 mm., not reaching the growth ring, margin very narrow, germination dorsal, vestiture a heavy basal plac of pale tawny hairs and a broad, dense apical plac or tuft of pallid hairs which completes an orbicular outline for the bud as a whole. Leaf sheaths somewhat scabrous on the dorsal line, soon glabrate, green, little bloom, purple at base within; throat broad, crumpled, pallid, glaucous, the margin ciliate; collar broad, pallid, reaching and including the midrib, glaucous, the margins lannate; ligule 2–4 mm., the edge even; ligular processes, one well developed. Leaf blades suberect, except the tips, medium width, 5 cm., channeled and somewhat revolute, dull green, margin nearly even, the base sparingly ciliate.

On many soils this is a good, strong-growing cane but it has no outstanding advantages.

FC 214.—Bred at Central Fajardo, Porto Rico. Planted there on a field scale.

Erect, at length prostrate, fairly good stools. Stalks medium diameter, pale purple, heavy bloom. Internodes medium length, cylindrical or somewhat barrel-shaped, a little staggered, furrow none. Nodes constricted, rather oblique; growth ring medium width, about 3 mm., even, pallid or with a brownish line, not conspicuous; root band 6–8 mm., pallid, constricted below, rudimentary roots large, pallid, inconspicuous, in 2–3 rows; leaf scar glabrous, squarrose in front, appressed behind; glaucous band 8 mm., constricted, fairly

well marked. Buds obtuse, broader than long, 12 x 10 mm., thick, scarcely exceeding the growth ring, margin medium broad, nearly uniform, germination subapical, vestiture moderate, a short basal plac of tawny hairs but the basal third of bud somewhat hirsute, especially along the veins, a few scattered hairs at the shoulders and along the front base of the margin. Leaf sheaths with a vestiture along the median line, soon glabrate, green, tinted purple, no bloom; throat medium broad, crumpled, brownish, lannate, margins ciliate; collar pallid to brownish, reaching and including the midrib, glaucous, the margins lannate; ligule narrow, 1–3 mm., margin fimbriate; ligular processes none. Leaf blades suberect, channeled, the margins somewhat inrolled, rather broad, 5–6 cm., medium-green, margin serrulate, the base scantily ciliate.

This is a high-tonnage, medium-sucrose cane, best adapted to low, moist lands. It will probably never be extensively planted. It is susceptible to eye spot but rather less so than FC 306.

FC 306.—A seedling bred at Central Fajardo, Porto Rico, where it has been grown on a commercial scale for some years.

Erect, but at length prostrate, good stools. Stalks medium diameter, dark reddish brown, often marked with brown lines, scanty bloom. Internodes cylindrical, usually larger below, straight or nearly so, furrow short, poorly marked. Nodes scarcely constricted; growth ring narrow, 2–3 mm., elevated, greenish, then concolorous or darker; root band narrow, 6–8 mm., pallid or at length concolorous, rudimentary roots large, crowded, pallid, rather obscure, in about 3 rows; leaf scar glabrous, narrow; glaucous band narrow, 8 mm., somewhat constricted, well marked. Buds ovate, about 10 x 10 mm., slightly exceeding the growth ring, margin narrow, uniform, germination apical, vestiture scanty, a short tawny basal plac and short apical tuft. Leaf sheaths with scanty vestiture on the median line, soon glabrate, glaucous, tinted purplish; throat narrow, pallid, lannate, the center glaucous with margins heavily ciliate; collar pallid, glaucous, the margins lannate; ligule narrow, 2–4 mm., edge minutely fimbriate; ligular processes none. Leaf blades drooping, rather narrow, 4–5 cm. wide, flat, bright green, margins nearly smooth, the base ciliate.

This is a vigorous cane with high tonnage but only moderate sucrose. It is rather late in maturing. It is best adapted to low, heavy soils. In many localities it is proving so susceptible to eye spot that its further planting cannot be recommended.

H 109.—A seedling of Lahaina (= Otaheite) produced at the Hawaii Sugar Experiment Station. It is now the kind principally

planted on all of the best irrigated lands in Hawaii where it holds the world's record for sugar production per acre, 18.09 tons of 96 per cent sugar per acre on 120 acres at Central Ewa in 1924.

Usually soon declined or recumbent, good vigor on moist lands, fairly good stools, seldom arrows. Stalks long, medium diameter, 3–3.5 cm., green with a strong flush, heavy bloom. Internodes medium length, nearly straight, cylindrical, furrow well developed. Nodes not constricted, slightly oblique; growth ring broad, 3–5 mm., narrower behind, yellowish, at length dark green or purplish, even or slightly sunken; root band 8–10 mm., narrower behind, often tinged with purple, rudimentary roots large, pallid with purple centers, in 3–4 irregular rows; leaf scar glabrous, appressed behind; glaucous band poorly defined, obscured by the bloom of the internodes. Buds ovate to ovate-lanceolate, 10–18 x 10–12 mm., exceeding the growth ring by one-fourth, margin medium width, uniform, germination apical, basal plaes scanty but with a pronounced apical tuft. Leaf sheaths with a vestiture of short, soft, pallid hairs, greenish, not glaucous, not stained with purple at base within; throat broad, 15–20 mm., lannate, usually blackish; collar broad, whitened, glaucous, the margins slightly lannate, reaching the midrib; ligule broad, 4–5 mm., the margin slightly fimbriate; ligular processes only one developed, usually short. Leaf blades somewhat erect but the tips drooping, medium width, 6 cm., flat, bright green to glaucous green, very slightly serrulate, almost even, the base sparingly ciliate.

Naturally, in view of its great success in Hawaii, this cane is being widely tested in many parts of the world. Fabulous prices have often been paid for a few seed pieces. It usually proves to be a fairly good cane, but so far it gives no promise of equaling its Hawaiian record in any other locality. It seems to resist drought poorly and to require a deep, open soil. It seems to be quite resistant to root disease but it is susceptible to mosaic and is attacked by *Helminthosporium* leaf spot in Hawaii. It seems to be medium-season in maturity, ripening about with Crystalina but seldom quite equaling it in sucrose. Its tremendous sugar yields per acre seem to come from very high tonnage rather than from unusually rich juices. It is a cane that should certainly be thoroughly tested wherever the conditions seem favorable for it, but from the present evidence it seems improbable that it will be widely planted except in a few favored localities.

Java 51.[5]—This is another of the canes used by Mr. R. M. Gray

[5] Recognized by Dr. Van Harreveld as being the 51 Brucius of the Java reports.

of the Harvard Botanical Garden at Central Soledad, Cuba, in his extensive cane-breeding work. It seems to have been imported directly from Java in 1902. So far as known, it has not been planted commercially.

Erect, good vigor and stooling. Stalks long, medium stout, about 3.5 cm., purple, heavy bloom. Internodes long, 10 cm. or more, not staggered, cylindrical, no furrow. Nodes even, not constricted and not oblique; growth ring broad, 4–5 mm., even or slightly swollen, pallid, then dark purple, conspicuous; root band narrow, 8 mm., slightly constricted, pallid, then subconcolorous, rudimentary roots crowded, pallid, in 2 or 3 rows; leaf scar glabrous, narrow, appressed behind; glaucous band obscured by the bloom of the internode. Buds small, triangular-ovate, 8–9 x 8–9 mm., reaching but scarcely exceeding the growth ring, margin narrow, 1 mm., somewhat wider below, germination apical, basal places well developed, and extending up the margins almost to apex, a short apical tuft. Leaf sheaths with a vestiture of short, pallid, hairs, green with a reddish tint below, somewhat glaucous, faintly tinted at base within; throat broad, dark brown, densely lannate, with scattered stiff hairs behind the ligule; collar broad, reaching the midrib, dark, glaucous, the margins lannate; ligule 3–4 mm., fimbriate; ligular processes reduced to short, triangular projections. Leaf blades drooping, broad, 8 cm., dark green, minutely serrulate, the base scantily ciliate.

This is a fine-looking cane of great vigor. Little is known of its cultural characters.

Java Unknown.—A cane has been distributed under this name from the Experiment Station at Mayaguez, Porto Rico, with the statement that it was received from the East Java Experiment Station in a shipment of EK 28 seed. The Java people deny having sent any such seed and claim not to recognize specimens of it sent back for identification. The cane clearly belongs with the *S. sinense* group, but its origin and true name are unknown. It has been planted to some extent in Porto Rico and has been introduced in Cuba but not planted on a field scale.

Erect, but at length prostrate, great vigor, very large stools, seldom arrows. Stalks long and slender, usually 2–2.25 cm., green, a reddish bronze flush when exposed, medium bloom. Internodes long, cylindrical but usually larger below, furrow usually none. Nodes enlarged, slightly oblique; growth ring about 2.5 mm., somewhat elevated, subconcolorous; root band 8–10 mm., enlarged, concolorous, rudimentary roots large with brown centers, usually in only 2 rows, occasionally a third broken row; leaf scar narrow, appressed behind; glaucous,

band about 8 mm., tapering downward, often poorly marked. Bud ovate, subacute (Uba-like), about 8 x 9 mm., exceeding the growth ring by about one-fourth, margin narrow, 1 mm., uniform, germination apical, basal places short and scanty, marginal vestiture of long hairs. Leaf sheaths subglabrous, green, little bloom, adhering closely to stalk; throat rather narrow, lannate with whitish hairs; collar narrow, scarcely reaching the midrib, dark brown, then pallid, glaucous; ligule Uba-like with triangularly widened center; ligular processes none. Leaf blades spreading, dark green, rather narrow, 4–5 cm., sharply but minutely serrulate, basal cilia very short and scanty.

Like most of the group, this cane is immune to mosaic and resistant to root disease. Like Uba, it is late in maturing but finally develops high sucrose. It is decidedly softer in texture than Uba and is often badly eaten by rats. The buds also average smaller and the stalks slenderer, but it can be most easily distinguished by usually having only 2 rows of rudimentary roots instead of 3. In tonnage and sucrose it will equal Uba, but it is so slender and the trash clings so closely that it is difficult to harvest and there seems no reason for planting it for sugar making. Its chief value would seem to be for forage. Its softer texture makes it preferable to Zwinga for this purpose.

Kassoer.—A wild cane of great vigor, found in the hills near Cheribon in Java. Cytological studies led to the belief that it was a natural hybrid between the wild *Saccharum spontaneum* and the Dark Cheribon. This has been confirmed by the making of artificial hybrids between these parents, some of which closely resemble Kassoer. Notwithstanding its great vigor and high tonnage it is nowhere planted commercially because it is too poor in sugar, but it is proving very useful in cane breeding since it imparts its vigor and disease immunity to its hybrid offspring. The later POJ series of big-barreled canes, now so popular in Java, all carry one-fourth of Kassoer blood.

Erect, very vigorous, a strong stooler, arrows frequently. Stalks very tall, 2–2.5 cm. in diameter, dull greenish purple, very heavy bloom. Internodes long, 12–14 cm., cylindrical, straight, not staggered, furrow none. Nodes not constricted or oblique, the lower ones often somewhat enlarged; growth ring broad, 3 mm. or more, even, yellowish or at length concolorous; root band broad, 10 mm. or more, even or the lower ones somewhat enlarged, pallid to concolorous, rudimentary roots large, rather crowded, the centers purplish, in 3 or 4 rows; leaf scar minutely ciliate with closely appressed hairs or at length glabrate, narrow, appressed behind; glaucous band obscured

by the bloom. Buds small, broadly oval, about 8 x 7 mm., obtuse, situated at least 3 mm. above the leaf scar but not exceeding the growth ring, margin about 1.5 mm., uniform or broader above, germination subapical, subglabrate, greatly reduced basal plaes and a very scanty marginal vestiture of long hairs. Leaf sheaths glabrate, green, scarcely glaucous, faintly or not at all tinted purple at base within; throat wide, 12 mm., dark, densely lannate; collar pallid, glaucous; ligule broad, 3–5 mm., broadest at the middle but not triangularly widened as in Uba, the edge fimbriate and lacerate; ligular processes both well developed, one usually very long and pointed, reaching 5 cm. or more. Leaf blade long, suberect, but the ends drooping, 4–5 cm. wide, dark bright green, minutely serrulate, the base scantily ciliate.

The best analysis so far seen of this cane was from variety plots in Cuba. When cut on April 7, 1926, at fourteen months, it gave Brix 16.90, sucrose 13.60, purity 80.47. By June 28, the same plots only gave Brix 13.39, sucrose 6.44, purity 48.10. Most Cuban analyses only run from 8 to 10 per cent sucrose in hand-mill tests, or but little more than half what would be expected from Crystalina under the same conditions. Notwithstanding its great vigor and tonnage and its immunity to mosaic, it cannot consequently be considered a commercial cane.

Kavangire.—This is the "Uba" of Argentina and Porto Rico, but it is not the true Uba of Natal although a closely similar kind, both belonging to the *Saccharum sinense* group, or the Pansahi group as they are called by Barber. This cane was never extensively planted in Argentina on account of its late maturity. On account of its immunity to mosaic it has been very widely planted in western Porto Rico and has played an important part in the rehabilitation of the industry of that region. It may be truthfully said that its importation in quantity from Argentina by the United States Department of Agriculture saved the sugar industry of western Porto Rico. Now that mosaic is well under control there, the tendency is to replace it with BH 10(12) and SC 12(4) but it is still widely planted and is an important factor in the industry.

Erect, very vigorous, stools tremendously, usually arrows early and very freely. Stalks very tall, slender, averaging about 2–2.25 cm., but often reaching 2.5 cm., green, often with a slight lilac tint where exposed, medium heavy bloom. Internodes long, 10 or 12–16 or 18 cm. Cylindrical or slightly larger below, not staggered, furrow none. Nodes normally of the same diameter as the internode, occasionally the lower ones enlarged; growth ring rather wide, 3–4 mm., even or

slightly sunken, concolorous or nearly so; root band slightly oblique, 7–9 mm., concolorous or yellowish, usually even, occasionally swollen on the lower nodes, rudimentary roots large, crowded, yellowish, in about 3 rows; glaucous band indistinct, blending with the bloom of the internode; leaf scar with circlet of hairs below the bud present but scanty and soon deciduous. Bud ovate, acute, about 10 x 14 mm., exceeding the growth ring by one-fourth, margin narrow, uniform, about 1.5 mm., germination apical, glabrate at base but with inconspicuous appressed hairs on margins, apical tuft very short and scanty. Leaf sheaths adhering strongly to the stalk, soon glabrate, except those on young suckers, which are densely prickly, greenish, scarcely glaucous, faintly tinted with purple at base within; throat subglabrous, the vestiture reduced to a few short hairs on the margins; collar narrow, reaching the midrib, glaucous; ligule with an abrupt triangular widening at the center where it reaches 4–5 mm., the ends only 1–2 mm., the margin irregular but scarcely fimbriate; ligular processes none. Leaf blades numerous, spreading, narrow, 3–5 cm., minutely but closely serrulate to the base, not ciliate.

The history of this variety, so far as it is known, is interesting. It, together with the true Uba, was evidently carried from India to Brazil in that early importation of varieties that followed the outbreak of gum disease in Brazil, probably about 1860. Kavangire was included in the long list of canes sent from Brazil to Argentina on the establishment of the Tucuman Station. Shortly after its introduction to Porto Rico, it was announced by the Director of the Tucuman Station that Kavangire had proved to be identical with Uba, hence the confusion of names in Porto Rico. On being grown side by side in Cuba they prove to be clearly distinct although closely similar. In fact, all of the varieties of this group resemble each other so closely that it is difficult to distinguish them. What these kinds were called in India, or later in China, we do not know. Uba proves to be the better cane of the two, being equally immune to mosaic, yielding fully as good tonnage and rather better sucrose, and shedding its trash better. There seems to be no reason for continuing the large-scale planting of Kavangire. Either Uba or CH 64(21) should be substituted for it.

Merthi.—Introduced from India by the U. S. Department of Agriculture as SPI 23243. It does not seem to be extensively grown in India and has nowhere been planted on a commercial scale in America.

A technical description would be almost word for word the same as for Uba and CH 64(21). There seem, however, to be some cultural

differences. As Merthi usually gives slightly less tonnage than Uba and is appreciably lower in sucrose content, there seems to be no reason for extending it. Quite possibly it may be the original stock in India from which the Uba has come, but in a group where the varieties run so closely alike this can hardly be taken for granted. Uba certainly resembles this kind more closely than any of the other known named varieties. Unfortunately, a selected strain of Uba has been rather widely distributed in Cuba under this name, but its history shows that it is the true Uba de Natal and is not a recent importation from India.

Negrita.—(A local name in Cuba. It is either the Djamprik or some closely related purple-leaved kind.) This is nowhere planted commercially but is occasionally seen planted as an ornamental or simply as a curiosity.

Erect, rather short, only medium stooler. Stalks short, slender, about 2.5 cm., dark purple, no bloom. Internodes short, 5–7 cm., cylindrical, no furrow. Nodes even, slightly oblique; growth ring 2–3 mm., pallid, then concolorous, even, blending with the root band; root band 8–10 mm., even, pallid, then concolorous, rudimentary roots large, crowded, purple centers, in 3 rows; leaf scar glabrous, narrow, appressed behind; glaucous band narrow, 6 mm., sharply defined. Buds lanceolate, or lance-ovate, large, 10 x 14 mm., exceeding the growth ring by one-third, margin narrow, 1 mm., uniform, germination apical, nearly glabrous, basal places greatly reduced, no marginal nor apical vestiture. Leaf sheaths glabrous, dark purple, glaucous; throat fairly broad, dark, crustose, minutely lannate, ciliate margins; collar dark, scarcely reaching the midrib, glaucous, the margins minutely lannate; ligule narrow, 2 mm., edge even; ligular processes none. Leaf blades erect except the tips, 5–6 cm., broad, tinted purple, the midribs dark purple, minutely serrulate, the base ciliate.

This is one of the old varieties, but it has no possible value except as a curiosity.

It seems to belong in the same taxonomic group as the Creole. Probably both should be referred to *S. officinarum* although they are quite distinct from most of the so-called noble canes.

Oshima.—This is one of the commercial canes of Formosa. We have no record of its being widely planted elsewhere. It was imported from Japan by the U. S. Department of Agriculture in 1910, as SPI 29109, and has been somewhat widely distributed to experimental collections. It is clearly of the *S. sinense* group but differs from Uba in the shorter, obtusely rounded buds.

Erect, very vigorous, a big stooler, arrows freely. Stalks very

tall, 2–2.5 cm. in diameter, green with a faint bronze flush when exposed, medium bloom. Internodes long, 10 cm. or more, cylindrical or nearly so, not staggered, no furrow. Nodes normally but little enlarged, not oblique; growth ring about 3 mm., even, concolorous or nearly so; root band 8–10 mm., concolorous, rudimentary roots with the centers brownish, in about 3 rows; leaf scar glabrous, narrow, appressed; glaucous band about 10 mm., fairly well marked. Buds ovate, obtusely rounded, rather small, about 9 x 10 mm., scarcely exceeding the growth ring, margin narrow, about 1 mm., uniform, germination subapical, basal plaes short and scanty, marginal vestiture of long, appressed whitish hairs, no apical tuft. Leaf sheaths subglabrous, green, somewhat glaucous, closely adhering; throat rather broad, pallid, minutely lannate with whitish hairs; collar pallid, glaucous, reaching the midrib; ligule wider at center but less conspicuously triangular than in Uba; ligular processes none. Leaf blades drooping, rather broad, 5–5.5 cm., rather light bright green, scarcely serrulate, the base very scantily ciliate.

On sandy-loam soils this kind gives even heavier tonnage than Uba but seems to have no advantage on heavier lands. In sucrose it is hardly as good as Uba. There seems to be no reason for extending it.

In the collections seen it is not taxonomically distinguishable from Tekcha which is also from Formosa, but it is by no means certain that they are identical.

Otaheite.—(= Bourbon, = Caña Blanca, = Lahaina.) For from seventy-five to one hundred years this was the only cane planted commercially in the West Indies after it so completely replaced the old Creole. It was carried to all parts of the world under one name or another and was a general favorite so long as there were rich new lands for planting. Unfortunately, it has a weak root system and it does not thrive when lands become hard and compacted. It is, too, particularly susceptible to practically all of the serious cane diseases and so, in one country after another, it went down, often as quickly and spectacularly as it had arisen, its sudden failure producing real crises in the sugar industry. It is still grown commercially to a limited extent in some parts of India and in a small way in Hawaii, and it is the principal commercial cane of Peru. Until the last few years it was still planted in Porto Rico but there the gum disease has driven it from its last stronghold among the hills. In practically all other sugar countries it has long since been abandoned in favor of hardier and better kinds. It was never a strong ratooner, and on old, exhausted soils it frequently fails to ratoon at

all. The present custom in some countries of taking only a few ratoon crops can be clearly traced to the old Otaheite tradition which still holds even when the variety itself has passed on.

Erect but soon procumbent, vigorous on suitable soils, medium stooler, poor ratooner, arrows frequently. Stalks long, medium stout, bright green, yellow at maturity, sometimes faintly tinted when fully exposed but with no distinct flush, bloom scanty or none. Internodes long, subcylindrical but inclining to barrel shape, straight or a little staggered, furrow evident but poorly developed. Nodes somewhat constricted; growth ring rather narrow, even or slightly sunken, concolorous or pale brownish; root band narrow, 5–8 mm., concolorous, rudimentary roots distant, white, then brownish, not conspicuous, in about 3 rows; leaf scar perpendicular to the stalk, glabrous, appressed behind; glaucous band clearly marked, usually constricted, narrow, 7–10 mm. Buds small, flat, often reddish when exposed, elliptic-ovate, acute, exceeding the growth ring by one-fourth of length, base rounded, margin narrow, 1 mm. or less, uniform, germination apical, places of short, crisped hairs at base, margin and apex with conspicuous appressed long hairs. Leaf sheaths with a dense vestiture of pallid, subappressed, acicular hairs, greenish, somewhat glaucous; throat brown, lannate with scanty tufts of long, soft hairs at the margins; collar brown, well marked, not reaching the midrib, sparingly lannate, especially toward the margins; ligule medium width, tapering from about 4 mm. at center to 1 mm. at ends, margin even; ligular processes well developed, unequal, one usually 14–18 x 6–7 mm., slender but obtuse, the other broader and shorter. Leaf blades suberect, flat, long and rather narrow, about 6 cm., bright but rather light green, minutely but closely serrulate, even or with scattered cilia at base.

That it was an exceptionally sweet cane is still believed by all the older generation of sugar men. This, however, is not confirmed by the long series of comparative analyses carried out in both Cuba and Porto Rico. Otaheite quite uniformly takes a lower place than Crystalina, both in sucrose and in purity. It was unquestionably a much better cane from every point of view than the Creole which it so quickly and completely replaced. With the much better varieties from which we may choose to-day, we do not need to regret its passing. It serves no good purpose, however, to suppose that this has been due to any deterioration of the Otaheite cane. It is as well adapted to-day as it ever was to planting in rich, virgin, river-bottom soils, and in such locations it will still compete with the best of them in tonnage for the first or plant crop. It is, however, so susceptible

to mosaic, to gum disease, and to root disease in all of its forms, and it ratoons so poorly, that its planting cannot be advised even in these favored localities.

Penang.—(In Porto Rico.) This is one of the old cane varieties that were evidently widely admixed in the old plantings of Otaheite. Being hardier than Otaheite and a much better ratooner, it has survived much better, and it is widely scattered in Porto Rico, usually as an admixture in Rayada fields although it has been selected out and planted as solid cultures in some cases. It is also known as Lucier and as Borbon. It has not been possible to determine its true name. Penang in the literature is usually a synonym for Salangor, which is a very different cane.

This, or a very similar cane, also occurs in Cuba as an admixture with Crystalina.

Erect, often soon procumbent, good average vigor, a good stooler, ratoons well, arrows frequently. Stalks medium diameter, light green, does not turn yellow, no flush, little or no bloom. Internodes rather long, cylindrical, straight, furrow shallow, often poorly defined. Nodes slightly constricted; growth ring broad, 2–5 mm., swollen, concolorous; root band narrow, 6–10 mm., concolorous, rudimentary roots few, distant, large, whitish with purple centers, in about 3 rows; leaf scar perpendicular to the stalk, glabrous, appressed behind; glaucous band narrow, well defined. Buds triangular-ovate, obtuse, 9–10 x 9–10 mm., not exceeding the growth ring, margin 1.5–2 mm., flat, slightly wider below, germination subapical, greenish or purplish, nearly glabrous. Leaf sheaths with a medium vestiture of short, pallid, subappressed hairs, glaucous, with a conspicuous lilac tinge; throat pale brown, minutely and sparingly lannate, with conspicuous tufts of long hairs on the margins; collar pale brown, glaucous, sparingly lannate toward the margins; ligule narrow, 1–3 mm., tapering toward the margins, edge even; ligular processes none. Leaf blades long, spreading, medium width, about 6 cm., dark green, minutely serrulate.

It matures later than Crystalina but usually develops about equally good sucrose. It is more resistant to root disease than Otaheite but is equally susceptible to mosaic and to gum disease. There is probably no reason for its continued planting.

POJ 36.—This is one of the early crosses made by Kobus at the East Java Experiment Station, the parents being the North Indian Chunnee x Striped Preanger. The first is taken by Dr. Jeswiet as the type of his new species, *Saccharum Barberi*. The second has been widely planted under the names of Rayada or Cinta, Mexican Striped,

Louisiana Ribbon, etc. Crystalina, or White Transparent, is the light colored variant and Louisiana Purple the dark variant.

This cane has never been extensively planted in Java, but its complete tolerance to mosaic and its great resistance to cold have caused it to become one of the two principal commercial varieties in Argentina, and now for the same reasons it is being extensively planted in Louisiana. These two factors both come from the Chunnee blood, but they were not important in Java where POJ 36 originated. It is also somewhat planted in West Porto Rico, and it is being planted on a field scale in Cuba.

Erect, good vigor, good stools. Stalks medium height, about 2.5 cm. in diameter, pale purple with heavy bloom. Internodes 8–9 cm. cylindrical, straight, not staggered, no furrow. Nodes not constricted, not oblique; growth ring about 2 mm., even, greenish or yellowish, at length subconcolorous; root band narrow, 6–8 mm., somewhat enlarged, the thickest part of the stalk, pallid, then concolorous, rudimentary roots in 2 to 3 rows; leaf scar glabrous, appressed behind; glaucous band narrow, 8 mm., tapering downward, fairly well marked. Buds suborbicular but broader than long, prominent, about 11 x 10 mm., not exceeding the growth ring, margin narrow, uniform, germination subdorsal, basal places short and scanty, marginal vestiture also short and scanty, apical tuft none. Leaf sheaths glabrous, pale green or sometimes slightly tinted with purple, not glaucous, stained purple at base within; throat broad, pallid, lannate, the margins ciliate; collar reaching and including the midrib, pallid, glaucous, the margins minutely lannate; ligule broadly rounded, 2–4 mm., fimbriate; ligular processes only one developed, short obtuse, usually less than 1 cm. Leaf blades long, drooping, 5–5.5 cm., bright green, margins scarcely serrulate, the base scantily ciliate.

This is a good general-purpose cane, adapted to a wide range of soil conditions. It is medium-season in maturity but its hardiness to cold makes it well adapted to subtropical conditions. When fully mature it develops high sucrose and purity.

Its remarkable tolerance to mosaic makes it available for planting in infected districts, since it will give practically full crops even when 100 per cent infected. Its planting, however, serves to propagate rather than to exterminate the disease. It is well adapted to poor, exhausted lands and can be safely planted where the noble canes are failing from soil exhaustion and root disease. It is a noteworthy cane from every point of view.

A sport with faint striping on the upper internodes is being widely planted experimentally as POJ 36 M.

POJ 100.—This is another of the early hybrids made by Kobus at the East Java Station. Unlike most of this early series, it is not based on Chunnee but is a cross of Loethers (= Soethers) on Bandjermassing Hitam, or Black Borneo. It has been grown to a considerable extent on a field scale in Java, but its chief interest is that it has been used so extensively in breeding. The famous seedlings POJ 2714, 2725, and 2878 all trace to it twice, once through the pistillate parent, POJ 2364, which is POJ 100 x Kassoer, and also through the staminate parent, EK 28, which is POJ 100 x EK 2, which in turn is Red Fiji x Lahaina (= Otaheite). It occurs widely in variety collections but does not seem to have been grown commercially outside of Java.

Erect, or at length prostrate, moderate stools. Stalks medium diameter, 3 cm. or more, green with a reddish-brown flush, little bloom. Internodes 8–10 cm. long, slightly staggered, somewhat barrel-shaped but larger below, furrow none. Nodes constricted, rather oblique; growth ring not uniform, often narrow, nearly even, pallid, then concolorous; root band wide in front, 10 or more mm., but narrowed behind, constricted, pallid, then concolorous, rudimentary roots large, scattered in 3 or sometimes 4 rows; leaf scar glabrous, prominent, appressed behind; glaucous band constricted, about 8 mm., well defined. Buds ovate-triangular, large 9–10 x 10–12 mm., exceeding the growth ring by one-fourth, margin nearly uniform, 1–1.5 mm., germination apical, basal plaes well developed, appressed marginal hairs, and a heavy apical tuft. Leaf sheaths with a heavy, white, stiff vestiture of sharp hairs, pallid-green, sometimes tinted, slightly glaucous; throat wide, 12 or more mm., brown, densely lannate, no long hairs; collar wide, brownish, reaching the midrib, glaucous and minutely lannate; ligule broadly rounded, 2–4 mm., conspicuously fimbriate; ligular processes usually one, short, obtuse. Leaf blades spreading, bright green, sharply serrulate, the base ciliate for 5 or 6 cm.

This cane is now less planted in Java than formerly. But little can be said of its cultural characteristics. Recent analyses in Florida indicate that it is very early in maturing. This may give it unexpected commercial value.

POJ 105.—(Egyptian, Ambar de Egypto.) This is one of the crosses between Chunnee and Black Cheribon made by Kobus in Java in the early days of the cane-breeding work. It seems to have been planted to some extent in Egypt, and was planted at least experimentally in Argentina. It was imported from Egypt to Porto Rico,

and after the mosaic outbreak there it was planted rather extensively on the west and north coasts.

Erect, vigorous, strong stooler, arrows freely. Stalks tall, slender, usually less than 2.5 cm,, brownish, very heavy bloom. Internodes long, cylindrical or a little compressed, furrow evident. Nodes prominent, enlarged; growth ring broad, even, yellowish; root band broad, rudimentary roots inconspicuous, purplish, in about 3 rows; leaf scar glabrous, equal on all sides, not compressed behind, the thickest part of the stalk; glaucous band indistinct, obscured by the bloom of the internode. Buds large, triangular-ovate, margin wide, strongly shouldered below (as in Crystalina), nearly glabrous. Leaf sheaths glabrous, long adherent, tinted; throat slightly lannate, with scanty tufts of hairs on the margins; collar glaucous, not lannate; ligule broad, especially at the center; ligular processes none. Leaf blades suberect but the tips declined, long, narrow, bright but rather dark green, scarcely serrulate, nearly even.

Like all of this series of hybrids, it is fully susceptible to mosaic but is at the same time so tolerant of its effects that the disease scarcely injures its productiveness. The few plots of this kind first found in these heavily infected districts in Porto Rico were very impressive on account of their much heavier tonnage and greater vigor as compared with the surrounding fields of diseased Rayada. At the present time, the planting of POJ 105 is not being increased in Porto Rico since there the tendency is very pronounced to discard these slender, tolerant and immune kinds that were at first used to counteract the mosaic, and to substitute BH 10(12), SC 12(4), and other high-sucrose but susceptible canes which are guarded by the methods of disease eradication. POJ 105 is a heavy-tonnage cane and a good ratooner but it is hardly as good in sucrose as POJ 36.

POJ 213.—Bred by Kobus at the East Java Experiment Station. Parents, Chunnee x Black Cheribon. Like the rest of this early series, this cane was never extensively planted in Java, but it came into prominence in Argentina during the mosaic outbreak there and is now the principal variety planted, this and POJ 36 being the only commercial canes of Argentina. It is now being largely planted in Louisiana where it is considered most promising, and where in another year it will probably be more widely planted than any other kind. It is also being planted in southern Florida. At the U. S. Department of Agriculture cane-breeding station at Canal Point, some of its seedlings are being used to cross on POJ 2725 with very promising results. It has also been used for breeding at Coimbatore in

India, being one of the parents in most of the best crosses made there.

Erect, good vigor, strong stooling and long ratooning. Stalks medium tall, slender, 2–2.75 cm., dark purple, medium bloom. Internodes long, about 10 cm., cylindrical, furrow slight but evident. Nodes even, not constricted, slightly oblique; growth ring 2.5 mm., even, yellowish, hard to distinguish from the root band; root band even or somewhat swollen on the lower nodes, 8–10 mm., yellowish, rudimentary roots very indistinct, in about 2 rows; leaf scar glabrous, narrow, appressed behind; glaucous band narrow, about 8 mm., fairly well marked. Buds triangular-ovate, about 10 x 11 mm., exceeding the growth ring by one-fourth, margin 1–1.5 mm., broader below but hardly shouldered, germination apical, nearly glabrous, the basal places short and scanty, no marginal vestiture, apical tuft very scanty or wanting. Leaf sheath glabrous, purplish, no bloom, stained purple at base within; throat narrow, brownish, lannate, the margins ciliate; collar narrow, reaching but not including the midrib, glaucous, the margins lannate; ligule broadly rounded, 4 mm., thin, often lacerate, minutely fimbriate; ligular processes none or one poorly developed, less than 0.5 cm. Leaf blades narrow, about 4 cm., dark green, fairly erect except the tips, margins nearly smooth, the base scantily ciliate.

This variety averages rather more slender than POJ 36. It is a little earlier in maturing but not as early as POJ 234. It carries very good sucrose. It is a strong ratooner and has considerable resistance to cold. It is very tolerant of mosaic, taking the disease freely but being scarcely injured by it. In South Africa it seems to be immune to the closely related streak disease. It is adapted to a wide range of soils and is said to stand wet land and lack of drainage unusually well. It must be included among the outstanding canes, being particularly useful for subtropical regions and for planting on poor lands, especially where there is heavy mosaic infection. It must be admitted, however, that canes of the Uba type will usually give much heavier tonnage under these conditions and will serve to help stamp out the mosaic and not to continue to propagate it.

POJ 228.—This is another of the early crosses made by Kobus at the East Java Station. Parents, Chunnee x Black Cheribon. Like POJ 36 and 213, it first came into prominence in Argentina during the mosaic outbreak there, but it never seems to have been widely planted on a field scale. It is found in experimental plots in all parts of the world.

Erect, good vigor, medium stools. Stalks fairly tall, medium-

slender, 2.5–2.75 cm., dark purple, heavy bloom. Internodes long, 10–15 cm., cylindrical, straight, not staggered, no furrow. Nodes somewhat swollen, scarcely oblique; growth ring 2.5–3 mm., slightly swollen, yellow, then concolorous; root band about 10 mm., swollen, yellow, at length concolorous, rudimentary roots large with brown centers, in about 3 rows; leaf scar lannate, appressed behind; glaucous band obscured by the bloom. Buds broader than long, obtuse, 11 x 10 mm., not exceeding the growth ring, margin narrow, 1 mm., uniform, on the top of the bud only, germination subdorsal, basal places extending upward as a marginal vestiture, a scanty apical tuft. Leaf sheaths glabrous, slightly tinted, scarcely glaucous, purplish at base within; throat narrow, brownish, lannate, the margins ciliate; collar pallid, reaching the midrib, glaucous, the margins minutely lannate; ligule broadly rounded, about 4 mm., minutely fimbriate; ligular processes usually well developed, short, less than 1 cm., obtuse. Leaf blades narrow, 4–4.5 cm., dark green, fairly erect except the tips, minutely serrulate, the bases scantily ciliate.

This seems to be a good cane in every respect. Its late maturity probably explains why it has not been more widely planted, since in Argentina early maturity is of first importance. Its tolerance to mosaic is not quite so pronounced as that of POJ 36 and 213, and its smaller stools as plant cane make for rather less tonnage at least for the first cutting. It develops good sucrose but is not at its best until late in the season. In tests at Baragua, Cuba, 5/16–27, at 19 2/3 months it gave Brix 22.98, sucrose 20.22, purity 91.12, extraction 67.93, being first in sucrose out of 188 kinds. The month before, it gave 21.64 sucrose and was third out of 209, being slightly exceeded by POJ 234 and by BH 10(12). In December, however, canes from the same plot only gave 9.61 sucrose and 71.40 purity. It ratoons strongly, the stools tending to become much heavier with age. Where canes of this class are being planted within the tropics, this variety should be carefully considered.

POJ 234.—One of the early series of hybrids bred by Kobus at the East Java Station. Parents, Chunnee x Dark Cheribon. Like the rest of this series, it has never been planted extensively in Java. It was among those to receive attention in Argentina, but it has never been planted as extensively there as 36 and 213. It has been planted to some extent in western Porto Rico, and now it is being extensively planted in Louisiana. It was the first of this series to reach that state and has been multiplied much more than any of the others.

Erect, or at length prostrate, good vigor, medium stools. Stalks tall, slender, about 2.5 cm., green, with a faint flush and medium to

heavy bloom. Internodes long, 10/12 cm., cylindrical, not staggered, furrow slight, often none. Nodes even or slightly swollen, not oblique; growth ring broad, 3–4 mm., slightly swollen, greenish; root band narrow, 7–8 mm., slightly swollen, pallid, rudimentary roots obscure, in about 2 rows; leaf scar minutely lannate, appressed behind; glaucous band indistinct, obscured by the bloom of the internode. Buds broadly triangular-ovate, 10 x 10 mm., scarcely exceeding the growth ring, margin narrow, shouldered below, germination apical, basal place much reduced, margin and apex glabrous. Leaf sheaths glabrous, green, no bloom, not purple at base within; throat brown, crustose, lannate toward the margins, cilia behind the ligule at margins; collar pallid, reaching the midrib, glaucous, not lannate; ligule broadly rounded, 3–4 mm., edge nearly even; ligular processes usually one, slender, acute, about 3 x 10 mm. Leaf blades spreading, 4–4.5 cm., bright green, minutely serrulate, the base ciliate.

Like most of this series, this variety is tolerant of mosaic but it shows its effects rather more than do 36 and 213. It is a prompt germinator and the ratoons start very quickly after the crop has been cut. This has proven a disadvantage in Argentina and Louisiana where in early-cut fields the ratoons grow up so quickly that they are likely to be injured by the cold. This has given POJ 234 the reputation of being a poor ratooner. This, however, is not the case, for in the tropics it ratoons unusually well. It is an early variety, or at least it shows fair sucrose early. Series of analyses in Cuba, however, show that it does not reach its greatest richness, before April, at the age of about eighteen months. In one series of analyses at the end of April, it took first place in sucrose content out of a lot of 209 kinds, including Badila and BH 10(12). This is a remarkable record and shows that the cane deserves serious consideration for tropical planting. Its slender diameter and the fact that the trash clings objectionably have caused it to make a poor impression. It grows well on poor lands and seems particularly adapted to light, sandy soils.

POJ 826.—This is another of Kobus' crosses at the East Java Station. It too is Chunnee x Dark Cheribon. It does not seem to have been planted extensively anywhere though it is widely distributed in experimental plots.

Erect, good vigor, medium stools. Stalks tall, slender, 2.5 cm., or a little over in diameter, purple, with a heavy bloom. Internodes long, about 10 cm., cylindrical, not staggered, furrow none or very slightly marked. Nodes even or slightly swollen, not oblique; growth ring broad, 3–4 mm., even or slightly swollen, green, then yellow, and

finally dark purple; root band narrow, 7–8 mm., slightly swollen, pallid, then concolorous, rudimentary roots large, rather obscure, in about 2 rows; leaf scar glabrous, appressed behind; glaucous band obscured by the bloom of the internode. Buds broadly triangular-ovate, often broader than long, 10–11 x 10 mm., scarcely exceeding the growth ring, margin broadly shouldered below, germination apical, basal places extending well up on the shoulders of the margin, a pronounced apical tuft. Leaf sheaths with a short, appressed vestiture of pallid hairs, strongly tinted purple, glaucous; throat narrow, lannate, cilia behind the ligule near the margins; collar narrow, scarcely reaching the midrib, glaucous, minutely lannate on the extreme margins; ligule broad, 4–5 mm., fimbriate; ligular processes greatly reduced, 3–4 mm., slender. Leaf blades erect except the tips, 4.5 to 5 cm. wide, bright green, sharply serrulate, the bases ciliate.

Like POJ 234, this is less tolerant of mosaic than 36 and 213; still, it is not seriously injured. It develops good sucrose fully as early as 234 but, like that kind, is not at its best before April. It seems to be a desirable cane for general planting. Although rather slender it cleans itself of trash remarkably well. It closely resembles 228 but can be distinguished by the broad, shouldered margins of the buds and by the vestiture on the leaf sheaths.

POJ 979.—A cane produced at the East Java Station in 1905, parents Chunnee x Dark Cheribon. This is a stouter cane than most of this series of crosses. It is a fine-looking cane of great vigor but nowhere seems to be extensively planted.

Erect or at length sometimes prostrate, good vigor, medium stools. Stalks long, medium diameter, 3–3.5 cm., green, with a pink flush, heavy bloom. Internodes long, 10–15 cm., cylindrical or slightly larger below, not staggered, furrow usually well marked but sometimes none. Nodes slightly swollen, oblique; growth ring broad, 3–4 mm., slightly swollen, greenish, at length purple; root band oblique, 7–10 mm., slightly swollen, pallid to concolorous, rudimentary roots small, scattered, purplish, in 3 rows; leaf scar glabrous, appressed behind; glaucous band evident but somewhat obscured by the bloom of the internode. Buds obscurely triangular-ovate but broader than long, 10–11 x 11–12 mm., scarcely exceeding the growth ring, the margin broadly shouldered, germination apical, well-developed basal places and a marginal vestiture of pallid hairs, with a long apical tuft. Leaf sheaths glabrous, green, sometimes tinted, somewhat glaucous, lightly tinted with purple at base within; throat broad, densely lannate, no long hairs; collar pallid, reaching the midrib, glaucous, not lannate; ligule narrow, 2–3 mm., margin even; ligular processes about

1 cm., long, broad, and obtuse. Leaf blades erect except the tips, bright but dark green, 5.5–6 cm. wide, serrulate, the base ciliate.

This is a vigorous high-tonnage cane but it is late in maturing and never seems to develop really good sucrose. Analyses indicate a quality comparable to that of Cavengirie. It is badly damaged and broken by high winds. There seems to be no reason for continuing to plant it.[6] In general appearance this cane resembles its noble parent much more than most of these hybrids.

POJ 2364.—Bred at the East Java Station, parents, POJ 100 x Kassoer. This handsome cane is probably too low in sucrose ever to be planted commercially but it is proving to be invaluable for breeding purposes. Used as the pistillate parent and crossed with EK 28, it has produced POJ 2714, 2725, and now POJ 2878 which is considered to be the best cane ever produced in Java. Crossed on Batjan, it has given POJ 2727.

Erect, good vigor, good stools, arrows freely. Stalks tall, medium diameter, 3–3.25 cm., light reddish brown, no bloom. Internodes long, 12–16 cm., cylindrical, slightly staggered, no furrow. Nodes slightly swollen, somewhat oblique; growth ring broad, 3–4 mm., slightly swollen, green, then purple; root band 8–11 mm., slightly swollen, green, rudimentary roots large with purple centers, in about 3 rows; leaf scar glabrous, appressed behind; glaucous band 8–10 mm., well marked. Bud large, suborbicular, about 12 x 12 mm., scarcely exceeding the growth ring, margin broad, 2 mm., nearly uniform, germination subdorsal, basal plaes well developed, scanty marginal vestiture and a pronounced apical tuft. Leaf sheaths subglabrous but with a few stiff, appressed hairs on the dorsal line, green or faintly tinted, somewhat glaucous, not stained with purple at base within; throat broad, dark, densely lannate, with a few long hairs behind the ligule; collar broad, brown, reaching the midrib, sparingly lannate; ligule 3–4 mm., edge long, fimbriate; ligular processes usually one developed, short, triangular, less than 1 cm. Leaf blades spreading, 6–7 cm. wide, minutely serrulate, the base scarcely ciliate.

This is a striking-looking cane, having much the aspect of POJ 2714, but lighter in color. Unfortunately, it seems to be poor in sucrose although only a few analyses are available.

POJ 2714.—Bred at the East Java Station. Parents POJ 2364 x EK 28 (for discussion see POJ 2725). This has been less planted than POJ 2725, but at present it is also attracting world-wide attention.

[6] Later analyses from Louisiana and Florida make a rather better comparative showing, but reports from the Argentine are all low.

Erect or at length recumbent, good vigor, heavy stools, arrows less frequently than POJ 2725. Stalks long, stout, about 4 cm., dark wine color, no bloom. Internodes long, 10–12 cm., cylindrical, not staggered, furrow slight but usually evident. Nodes even, slightly oblique; growth ring about 3 mm., green, at length dark purple, somewhat swollen; root band broad, 8–11 mm., slightly swollen, green, at length nearly concolorous, rudimentary roots large, prominent, crowded, the centers purple, in 3 rows; leaf scar glabrous, appressed behind; glaucous band about 8 mm., well-marked, conspicuous. Buds triangular-ovate, 10–12 x 10–12 mm., exceeding the growth ring by one-fourth, usually 1–2 mm., above the leaf scar, margin broad, 2 mm., nearly uniform, germination apical, basal places well developed, ending in a tuft of long hairs at base of margin, true marginal vestiture scanty or none, apical tuft scanty. Leaf sheaths at first with a dense vestiture of stiff, pallid hairs which are partially deciduous, leaving the older sheaths subglabrate, strongly tinted, somewhat glaucous, very slightly tinted at base within; throat medium narrow, pale brownish, sparingly lannate toward the margins; collar pallid or pale brownish, hardly reaching the midrib, glaucous, the extreme margins minutely lannate; ligule 3–4 mm., thin, minutely lannate, the edge undulate; ligular processes reduced to a short, triangular tooth. Leaf blades spreading, broad, 7–9 cm., somewhat involute, minutely serrulate, the base ciliate.

This is a strikingly handsome cane and seems destined to become exceedingly popular on account of its fine appearance, great tonnage, and great resistance to mosaic. It is also remarkably resistant to most forms of root disease. It seems to require moister soils than POJ 2725 and to be later in maturing. It is doubtful if it will average as high in sucrose.

POJ 2725.—Bred at the East Java Station. Parents, POJ 2364 x EK 28. POJ 2364 is Kassoer x POJ 100, and EK 28 is POJ 100 x EK 2 which last is Red Fiji x Lahaina (Otaheite). POJ 100 is Loethers x Black Borneo. This remarkable cane, therefore, carries one-fourth Kassoer, one-fourth Black Borneo, one-fourth Loethers (or Soethers), one-eighth Red Fiji, and one-eighth Otaheite. As Kassoer is supposed to be *S. spontaneum* x Dark Cheribon, one-eighth of each of these is represented. POJ 2714 and the new POJ 2878 have identically the same parentage. This variety occurs in Java on a field scale but has never been planted there extensively. It is being planted considerably in Argentina and to some extent in Porto Rico. At the moment it is attracting more attention than any other variety in Cuba where high prices are being paid for all available seed.

Erect but at length prostrate, great vigor, large stools, usually arrows early and very freely. Stalks long, medium diameter, 3–3.25 cm., green with a dull brownish flush, little or no bloom. Internodes long, 10–12 cm., cylindrical, slightly or not at all staggered, furrow very slight but usually evident Nodes even, slightly oblique; growth ring about 3 mm., slightly elevated, pallid, at length concolorous; root band oblique, 7–10 mm., pallid, then dark green, rudimentary roots rather inconspicuous, in 3 rows; leaf scar glabrous, appressed behind; glaucous band 8 mm., rather scanty. Buds narrowly ovate, almost oval, acute, 8 x 10 mm., exceeding the growth ring by one-fourth to one-third, margin broad, 2 mm., nearly uniform, germination apical, basal places moderate, a heavy marginal vestiture, mostly on the margin itself, a well-developed apical tuft. Leaf sheaths with a heavy, very stiff, whitish vestiture which is at length partially deciduous, green, glaucous, not tinted at base within; throat very broad, dark, densely lannate, scattering long hairs behind the ligule; the collar broad, pale brown, reaching and including the midrib, lannate; ligule 3–4 mm., edge conspicuously long fimbriate; ligular processes broad, obtuse, less than 1 cm. long. Leaf blades widely spreading, dull green, about 8 cm. wide, flat or somewhat inrolled, sharply serrulate, the base very scantily ciliate.

The great popularity of this cane in Cuba is largely due to its strong resistance to mosaic. It is not absolutely immune but it takes the disease so rarely that for all practical purposes it may be considered as being so. It is one of the few large-diameter canes that can be planted safely in heavily infected districts. It seems to be adapted to a wide range of soils and shows great vigor and high tonnage on lands so poor and exhausted that Crystalina is failing. It is, too, a very strong ratooner. It develops some sucrose very early, so that it is being seriously considered in both Argentina and Louisiana, but it is really a mid-season cane, ripening about with Crystalina and equaling or sometimes exceeding it in richness. Its only objectionable characters are its inordinate tendency to early and very free arrowing and the unusually rough, prickly leaf sheaths which make it unpleasant to handle. On account of the heavy arrowing, it should always be cut early in the season. Clearly, it is not well adapted to carry over as "long crop" cane (caña quedada).

In badly mosaic-infected districts plantings made half with this variety and half with Uba or CH 64(21), which hold sucrose so well late in the season, should make an admirable combination.

POJ 2727.—One of the later series of hybrids produced in Java. The parents are POJ 2364 x Batjan. It thus differs from POJ 2714

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and 2725 in being based on Batjan instead of EK 28, but, like them, it carries one-fourth of Kassoer blood. It has been planted in a small way in Java but so far only experimentally in Argentina, Cuba, and Porto Rico. It promises, however, to be a commercial cane of considerable importance.

Erect, very good vigor, medium stooling. Stalks long, medium diameter, 3–4 cm., green, little or no flush, no bloom. Internodes cylindrical, long, 8–13 cm., not staggered, no furrow. Nodes not constricted, even, not oblique; growth ring narrow, 2–3 mm., elevated, concolorous; root band narrow, 6–8 mm., concolorous, rudimentary roots large, rather crowded, in about 3 rows; leaf scar minutely lannate, narrow, appressed behind; glaucous band about 8 mm., poorly marked. Buds suborbicular, about 10 x 10 mm., reaching but not exceeding the growth ring, often reddish, margin wide, 2–2.5 mm., wider below but hardly shouldered, germination apical, basal plaes scanty, almost none, margins lannate, with short, scattered, dark hairs, a few scattered long hairs from below the margin but no apical tuft. Leaf sheaths glabrous, green or very faintly tinted, slightly glaucous, not colored at base within; throat lannate with whitish hairs, the margin ciliate; collar well marked, dark, reaching the midrib, glaucous, the margins faintly lannate; ligule rounded, 2–4 mm., irregularly fimbriate and lannate, ligular processes short and obtuse, often none. Leaf blades suberect, the ends drooping, dark bright green, narrow, about 5 cm., the margins scarcely serrulate, the base ciliate.

This is a vigorous cane of high tonnage. It is less immune to mosaic than 2725 but it takes the disease very rarely, and it is remarkably resistant to all forms of root disease. Its sucrose content is not fully determined but seems to be rather low. The smooth sheaths make it much pleasanter to handle than POJ 2714 and 2725. It seems particularly well adapted to dry, rocky lands, almost equaling CO 213 in such locations.

PR 433.—Parents unknown. This is one of the best of the Porto Rican seedlings. It has been planted on a field scale in Porto Rico and in eastern Cuba.

Erect, vigorous, good stooler, seldom arrows. Stalks medium to medium-stout, green, little or no flush, heavy bloom. Internodes medium length, not staggered, cylindrical, furrow very slight or none. Nodes not constricted; growth ring narrow, 2–3 mm., even, concolorous, inconspicuous; root band narrow, 6–8 mm., concolorous or a little darker green, rudimentary roots small, crowded, yellowish green, in about 4 confused rows; leaf scar glabrous, appressed behind; glaucous band narrow, 6–8 mm., not constricted, rather well marked. Buds

broadly ovate, subacute, somewhat exceeding the growth ring, margin wide, uniform, germination apical, heavy basal places extending up on to the margins, and a short but heavy apical tuft. Leaf sheaths subglabrous, green, somewhat glaucous; throat lannate and with scanty marginal hairs; collar broad, pallid, reaching the midrib, glaucous, not lannate; ligule broad, about 5 mm., edge nearly even; ligular processes none. Leaf blades spreading, medium width, about 6 cm., somewhat revolute, medium green, minutely but closely and sharply serrulate, the base even, not ciliate.

It is a medium-season cane and on good lands yields very heavy tonnage. It is about equal to Crystalina in sucrose. Its ratooning ability has not been fully tested but it is a promising commercial cane, probably best adapted to moist, black lands.

It is susceptible to mosaic and in Porto Rico to the vascular-bundle disease.

PR 492.—Parents unknown. It is being planted on a field scale in both Porto Rico and eastern Cuba.

Erect, vigorous, good stooling, seldom arrows. Stalks medium-stout to stout, green, yellowish at maturity, no flush, little or no bloom. Internodes medium to long, not staggered, somewhat enlarged below, furrow slight or none. Nodes scarcely constricted; growth ring broad, 4–5 mm., nearly even, bright brown, conspicuous; root band narrow, 8 mm., concolorous, rudimentary roots conspicuous, brown, in about 3 confused rows; leaf scar glabrous, appressed behind; glaucous band, slightly constricted, well marked. Buds ovate, medium size, slightly exceeding the growth ring, often reddish, margin rather broad, uniform, germination apical, basal places moderate, marginal vestiture heavy, ending in a conspicuous apical tuft. Leaf sheaths nearly glabrous, long, light green, glaucous, purplish at base within; throat dark brown, lannate and with a scanty vestiture of long hairs; collar conspicuous, dark smoky brown, not reaching the midrib, glaucous and scantily lannate with whitish fibers; ligule medium, 3–4 mm., edge even; ligular processes none. Leaf blades erect, the tips declined, flat, broad, 8–10 cm., rather dark green, margin nearly even, scarcely serrulate, the base not ciliate.

This is a heavy-tonnage cane but it requires moist, rich lands. It is earlier in maturing than Crystalina and develops fully as good sucrose. It is susceptible to mosaic and to the vascular-bundle disease. It stands strictly erect but, unfortunately, it is rather brittle and is often broken off at the ground by heavy wind. This is perhaps its greatest weakness.

Salangor.—This is one of the old standard kinds formerly frequently mentioned in the literature. In recent years it has been quite completely neglected. It is still grown somewhat in certain parts of India and on one plantation in Porto Rico where it was making a very good showing in comparison with Rayada.

Erect, but often soon declined, vigorous, seldom or never arrows. Stalks long, medium stout, pallid or yellowish, no flush, very heavy bloom, usually marked by faint blackish lines or longitudinal checks that are more or less obscured by the bloom. Internodes medium length, straight, barrel-shaped, furrow faint or none. Nodes constricted; growth ring inconspicuous, poorly marked, concolorous; root band narrow, less than 10 mm., at first whitish then greenish, rudimentary roots numerous, crowded, small, purplish, in about 4 irregular rows; leaf scar glabrous, somewhat oblique, appressed behind; glaucous band obscured by the heavy bloom. Buds ovate-acuminate, rather large, about 10 x 15 mm., exceeding the growth ring by one-third or more, often purplish, margin uniform, rather broad, germination subapical, nearly glabrous except for a heavy tuft of long, curled hairs on either side above the base. Leaf sheaths with an abundant vestiture of short, suberect, rather weak, pallid hairs, pallid or greenish, strongly glaucous, purplish at base within; throat dark brown, densely lannate and with a fringe of long hairs behind the ligule and at the sides; collar conspicuous, reaching the midrib, reddish brown, then dark brown, glaucous, not lannate; ligule of medium length; ligular processes none or short and inconspicuous. Leaf blades spreading, flat, 5–6 cm. wide, light green, minutely but distantly serrulate, the base ciliate.

It seems to be best adapted to low, moist lands and it is reported to be rich in sucrose although no recent analyses are available. It seems to ratoon well and to be fairly resistant to root disease but, like the rest of the so-called noble canes, it is susceptible to mosaic. Its reaction to gum disease has not been determined.

SC 12(4).—This remarkable cane was grown by Longfield Smith at the Santa Cruz Experiment Station in the Virgin Islands, but it was said to be one of a lot of seedlings brought with him from Barbados when he became the director of this station, and to be of the same parentage as BH 10(12), both being seedlings of B 6835. The numbering indicates that it was No. 4 of the year 1912, and so it was bred in the same year as the BH 10(12).

Erect, good vigor, a fair stooler and good ratooner, arrows frequently. Stalks long, medium diameter, green with a reddish flush,

light bloom. Internodes medium to long, cylindrical or a little compressed, staggered, furrow slight or none. Nodes somewhat constricted, strongly oblique; growth ring broad, but rather poorly defined, even or somewhat elevated, yellowish; root band strongly oblique, 5–10 mm., concolorous or paler, rudimentary roots crowded, in about 4 rows; leaf scar glabrous, broad and prominent in front, appressed behind; glaucous band constricted, poorly defined. Buds large, lance-ovate, about 12 x 16 mm., exceeding the growth ring by from one-third to one-half of length, margin broad, uniform, germi-

FIG. 6.—At the left Crystalina cane 12 months old. At the right Santa Cruz 12 (4), 10½ months old. Central Cupey, Oriente, Cuba.

nation apical, heavy basal plaes of crisped hairs and abundant marginal vestiture ending in a conspicuous apical tuft. Leaf sheaths with a dense vestiture along the back, the sides glabrate, greenish or slightly tinted, somewhat glaucous, the base slightly stained purple within; throat lannate and with an abundant vestiture of long hairs; collar medium width, reaching the midrib, glaucous, the margins slightly lannate; ligule about 4 mm., minutely fimbriate; ligular processes none. Leaf blades erect, usually even to the tips, flat, 7 cm. or more wide, dull green, minutely and sparingly serrulate, the base even, not ciliate.

These two canes are now being more widely planted in the West Indies than any other kinds and there is still keen competition

between them as to which shall be considered as holding first place. They are both mid-season canes, maturing about with Crystalina. At full maturity either one of them will give rather better sucrose than Crystalina, when at its best, usually running from 1 to 2 per cent higher, and on the best lands they will outyield Crystalina in tonnage. It is no wonder, therefore, that they have so completely replaced this old favorite in Porto Rico and that they are making rapid inroads on it in Cuba. They both ratoon very well on good lands but will probably fail more quickly than Crystalina where soils are worn and exhausted. They are decidedly not poor-land canes. As between the two, BH is usually the better germinator, or at least SC requires more moisture for good germination. It often fails badly if the weather is dry. With everything favorable, SC will often give slightly greater tonnage, but BH usually shows a little higher sucrose and purity. Both are equally susceptible to mosaic and should only be planted where this disease is being rigidly held in control. Both show very considerable resistance to gummosis. Of the two, SC is rather more resistant to the root-disease complex. BH closely resembles Crystalina in this respect, sometimes running down badly under conditions where Crystalina is failing.

There can be little doubt that the popularity of these two kinds will continue and that their planting will be widely extended in other parts of the world. So far in the West Indies at least, they have no competitors in sugar per acre yields on the best lands.

SW 3.—A seedling produced at Sempalwadak, Java, in 1904, Batjan being used as staminate and Dark Cheribon as pistillate parent. It has been planted to some extent in Java.

Erect but soon recumbent, rather small stools. Stalks slender, 2.5–3 cm., green with a very slight flush and medium bloom. Internodes medium length, 8–10 cm., cylindrical, not staggered, furrow slight but evident. Nodes not constricted, even, not oblique; growth ring 2.5 mm., even or slightly enlarged, pallid or yellowish, then concolorous; root band narrow, 6–8 mm., even, pallid, then concolorous, rudimentary roots crowded in about 4 rows; leaf scar glabrous, narrow, appressed behind; glaucous band narrow, 6 mm., fairly well marked. Buds broadly ovate, small, about 7 x 6 mm., not exceeding the growth ring, margin narrow, slightly shouldered below, and with a small mucronate apex, germination subapical, nearly glabrous. Leaf sheaths glabrate, greenish, somewhat glaucous; throat rather wide, crustose, not lannate, no long hairs; collar broad, dark, reaching and including the midrib, minutely lannate; ligule broadly rounded, 2–4 mm., the edge unequally fimbriate; ligular processes none. Leaf

blades spreading, narrow, 4.5–5 cm., dark green, minutely serrulate, base not ciliate.

From its slender stalks and narrow leaves it closely resembles Batjan, so much so that both might easily be confused with the *S. Barberi* hybrids, but Batjan is supposed to belong with the noble canes. Nothing can be said as to the cultural characteristics of SW 3. The little seen of it is not particularly promising.

Tekcha.—A variety grown commercially in Formosa. It was imported from Japan by the U. S. Department of Agriculture, in 1910, as SPI 29106.

In the collections seen, it is indistinguishable from the Oshima of the same importation, which see for description. Both belong to the *S. sinense* group but are said to be somewhat susceptible to mosaic. There seems to be no reason for propagating these canes in preference to Uba and CH 64(21), which will give equal tonnage, better sugar yields, and complete immunity to mosaic.

Toledo.—A strong-growing, vigorous cane, apparently immune to mosaic, found by Dr. Brandes as a stray in a cane plantation in the Philippines. It is now being grown there on a commercial scale. It has also been introduced in Cuba, Porto Rico, Louisiana, and Florida, but so far only experimentally.

Erect, good vigor, strong stooling, seldom arrows. Stalks tall, 2.5–3 cm. in diameter, dark purple with heavy bloom. Internodes long, 10–12 cm., cylindrical or slightly larger below, nearly straight, no furrow. Nodes slightly enlarged, somewhat oblique; growth ring 2.5 mm., slightly swollen, concolorous but darker; root band 8–10 mm., slightly oblique, concolorous, rudimentary roots in 2 or 3 rows; leaf scar glabrous, narrow, appressed behind; glaucous band narrow, tapering downward, obscured by the bloom of the internode. Buds semi-orbicular, about 10 x 10 mm., not exceeding the growth ring, margin 1–1.5 mm., on the upper side of the bud, germination subapical, basal pores very short and scanty, mostly obscured by a heavy deposit of wax, margin and apex glabrate or sometimes a very scanty vestiture of very short hairs. Leaf sheaths with a scanty vestiture of scattered, stiff, tawny hairs, green or often with a purple tinge, scanty bloom; throat broad, discolored, scantily lannate on the margins, a few short cilia on the shoulders; collar broad, reaching the midrib, discolored, glaucous; ligule broad, 4–5 mm., rounded, thin, often crumpled and lacerate, the edge conspicuously long-ciliate; ligular processes, one strongly developed, broad, often 2 cm. long. Leaf blades spreading, light green, rather broad, 5–6 cm., sharply serrulate, the base scantily ciliate.

The parentage of this cane is entirely unknown, but it resembles Kassoer in so many particulars as to suggest that it too may be a natural hybrid between the wild cane, *S. spontaneum,* and some noble cane. Its immunity to mosaic proves to be only partial, since occasional cases have been observed both in Porto Rico and the Philippines. The few analyses available indicate that it is fully as low in sucrose as Kassoer. It seems doubtful, therefore, if it will have any real commercial value. As compared with Uba, for instance, it will give rather less tonnage, less immunity to mosaic, and decidedly less sucrose.

T 77.—Bred in the island of Trinidad. This was one of the earlier of the West Indian seedlings to attract widespread attention. It has been planted on a field scale in Porto Rico and probably in other countries. It is a good cane but apparently not good enough to make a permanent place for itself, for now it is seldom seen, and but little is really known of its characteristics and capabilities.

Erect, at length reclined, medium stools. Stalks medium diameter, 3.5 cm., light purple, medium bloom. Internodes medium length, 7–9 cm., somewhat staggered, cylindrical or slightly compressed, furrow broad but shallow, extending entire length of internode. Nodes, constricted, oblique; growth ring medium broad, 3 mm., pallid, then concolorous or darker, slightly sunken; root band oblique, 1 cm. in front, 8 mm. behind, pallid, at length concolorous, rudimentary roots large, 3 mm., pallid, the centers purplish, in 3 broken rows; leaf scar broad in front, appressed behind, densely ciliate with long, pallid hairs; glaucous band strongly constricted, well defined, 8–10 mm. Bud lanceolate, 10 x 20 mm., exceeding the growth ring by one-half of its length, margin medium broad, 2 mm., abruptly widened below, germination apical, basal plaes short but well developed, sides glabrate but with a well-developed apical tuft of long hairs. Leaf sheaths with a scanty, often deciduous, vestiture mostly confined to the back half of sheath, green or faintly tinged with purple, somewhat glaucous; throat narrow, less than 10 mm., densely strigose with whitish hairs; collar narrow, lannate, reaching the midrib; ligule short, 3–4 mm., edge serrate; ligular processes none. Leaf blades erect, except the tips, long 1.25 m., rather narrow, 6.5 cm., nearly flat, bright dark green, margins serrate with short, sharp, hooked teeth but becoming smooth with age, the base ciliate.

Uba.—The history of this remarkable cane can be briefly stated as follows: It seems to have been one of the shipment of Indian canes sent to Brazil at the time of the first outbreak of gum disease, probably about 1860. The name first appears in the literature in 1869

when it was included in a long list of canes sent from Brazil to Mauritius, the only comment on it in this first report being "a worthless cane," the people in Mauritius evidently having the prevailing prejudice against slender canes. However, it seems to have been sent to Natal where it was soon found to be resistant to the prevailing "degeneration" of the older kinds and it quickly became the only cane planted. For many years the entire sugar crop of Natal has been made from this slender but vigorous cane. It is only in recent years that it has been realized that the "degeneration" of the canes in Natal was due to an outbreak of mosaic. Uba has also been extensively planted in Jamaica for combating mosaic, and it is widely

FIG. 7.—A field of Uba Cane, Colonia El Conde, Central Hershey, Cuba. Photograph by J. R. Zell.

scattered in Cuba but is only extensively planted on a few estates, most of the people being strongly prejudiced against slender canes.

A technical description of Uba would read, word for word, the same as CH 64(21), which see. Although no one character can be found by which they can be certainly distinguished, there are some cultural differences between them. The foliage in Uba averages a little darker green and is less spreading, it arrows rather more freely, and the buds are more likely to sprout on the standing cane. On heavy soils there will be no great difference in tonnage, but on sandy loams Cuba 64(21) will outyield Uba. They are equally late in maturing but both develop good sucrose when fully ripe and both hold it well late in the season. Both are equally immune to mosaic and to most forms of root disease, but both are seriously injured by

the moth borer. Everything considered, these two are the best of the *S. sinense* type, and they can be planted profitably where the noble canes fail completely. It should be remembered, however, that on low moist lands it is very difficult to mature them sufficiently to develop satisfactory sucrose. Such low lands are often acid in reaction, and recent work both in Natal and Cuba indicates that Uba develops much better sucrose and purity on alkaline than on acid soils. For the present, therefore, it will be safer to confine plantings of Uba to uplands having an alkaline reaction.

Yellow Caledonia.—Ten years ago the planting of this cane was probably being extended more rapidly in all parts of the world than that of any other variety. To-day it is everywhere losing ground, being crowded out by better sucrose canes, notably by H 109 in Hawaii and b BH 10(12) and SC 12(4) in the West Indies. It is quite improbable that it will ever again become as popular as in the past.

Strictly erect, very vigorous, fair stooling, seldom arrows. Stalks medium-stout, green, with a heavy reddish flush where exposed, bloom little or none, often marked with brown lines. Internodes medium length, straight, cylindrical, furrow none. Nodes not constricted; growth ring rather broad, 2–4 mm., even or a little sunken, usually light green; root band narrow, somewhat oblique, 6–10 mm., greenish, rudimentary roots small, dark purple, in 3 to 4 rows; leaf scar glabrous, nearly perpendicular to stalk, narrow, appressed behind; glaucous band conspicuous, narrow, about 8 mm. Buds broadly ovate or nearly orbicular, small, often purplish, about 10 x 10 mm., usually reaching but not exceeding the growth ring, margin uniform, very narrow, germination long delayed, subapical, nearly glabrous except for the heavy apical tuft which reaches 4 mm. Leaf sheaths glabrous, green or sometimes tinted below, glaucous, conspicuously tinted with purple at the base within; throat wide, dark brown, densely lannate, a circle of sparse, rather short hairs behind the ligule especially toward the margins and extending on to the shoulders; collar broad, dark brown, extending to the midrib, densely lannate; ligule 2–4 mm., the ends tapering, margin uneven, somewhat fimbriate; ligular processes none. Leaf blades erect but with the tips declined, flat, broad, 7–8 cm., dark green, very minutely serrulate, the margin even below, or sometimes scantily ciliate.

On moist rich lands it gives very heavy tonnages. As usually cut, it is low in sucrose, but this is largely because it is late in maturing. When fully ripe it sometimes gives almost as good sucrose as Crystalina. It has some resistance to ordinary forms of root disease, but

in most soils it is an only moderately good ratooner, usually going out rather more quickly than Crystalina. In some cases in Porto Rico this was due to the vascular-bundle disease (Plasmodiphora) to which it is rather susceptible. It is practically immune to gum disease. It contracts mosaic a little less readily than some other kinds, but when once attacked it is very severely injured, being conspicuously dwarfed and sometimes actually killed.

Zwinga.—This cane was brought to Louisiana from Japan in 1877. It has been considerably planted in the southern United States as a fodder crop, and to a limited extent for syrup making. There is no record of its being used for sugar making. From Louisiana it has been sent to Cuba, Porto Rico, and Argentina but has only been planted experimentally. It seems probable that this is the cane known as Uba in Hawaii, since it was imported there from Louisiana in the early days when, so far as is known, this was the only cane of this type to be found there. If so it has been used rather extensively in breeding work.

This is another cane of the *S. sinense* group that resembles Uba so closely in technical characters that it seems useless to give a separate description. It is, however, distinctly inferior in cultural characters. It is usually rather thinner in diameter, and the trash clings much more closely. It is even later in maturity and develops decidedly less sucrose. There seems to be no reason for continuing to plant it. Even for fodder, it is hard and woody, the Java Unknown being softer and sweeter.

CHAPTER V

SUGAR-CANE DISEASES

As we have already seen in the historical review in the introductory chapter, the sugar-cane industry has at various times and in many parts of the world suffered serious and often sudden injury from the outbreak of some cane disease. We have also seen how in each case the situation has been met either by a change in variety or by some radical change in methods of cultivation. So far, no practicable remedy has been discovered for any of the principal cane diseases, using this term in its usually accepted sense as being a spray or other topical application.

According to the view at present accepted, all commercially grown cane varieties are descended from one or another of four species of *Saccharum*. These are *S. officinarum*, or the so-called noble or tropical canes; *S. sinense*, the Chinese or Japanese canes; *S. Barberi*, the North Indian canes; and *S. spontaneum*, the wild canes. Then, too, there are many kinds that are hybrids, combining the blood of two or more of these species. These various races are quite different in their susceptibility to the principal cane diseases. For some of them, the reaction can be foretold with considerable certainty. Thus practically all of the noble canes are susceptible to mosaic. The Chinese and wild canes, on the contrary, are highly resistant or practically immune, and this character proves to be dominant in most crosses. The North Indian canes are susceptible but usually very tolerant, being injured but little by the disease, and this character too is usually dominant in hybrids.

The noble canes are usually susceptible to the so-called root-disease complex, while the other three races all show a very considerable degree of resistance to root troubles.

The Chinese canes, which are so resistant or practically immune to the two troubles mentioned above, are all particularly susceptible to smut, a disease to which most of the noble canes are quite resistant.

With gummosis, leaf scald, and sereh, the case is not quite so clear-cut, since, while most of the noble canes are susceptible, some

of them in each case show considerable resistance. The other three races show, for the most part, pronounced resistance or immunity.

While our knowledge of the whole subject is still very inadequate, we at last have enough light to point the way for the plant breeder, on whom, rather than on the pathologist, we must mainly depend for help in combating sugar-cane diseases. The commercial canes of the future will quite certainly be hybrids combining the blood of two or more, probably three, of the above races, thus giving us the high sugar content and good milling qualities of the noble canes together with the hardiness, high-tonnage, long ratooning, and disease resistance of the other races. The cane breeders of Java and India are already showing us the way.

Sugar Cane Mosaic.—For some years past, this has been attracting more attention than any other cane disease and has been causing serious losses in practically all parts of the sugar-cane-growing world. Notwithstanding the world-wide study and attention it has received, its cause is absolutely unknown. The same can be said of all the other mosaic diseases, of which there are many. They are all exceedingly infectious, and since we can account for an infection only by the presence of a living causal organism, they have been supposed to be caused by a filterable, ultramicroscopic virus with particles so small that they cannot be detected by the most powerful microscopes. When we cannot see a parasite we have to imagine one.

The mosaics are all spread in the field by the punctures made by various sucking insects. Some of them are also communicated by contact. In a few, seed inheritance occurs, but more often this is not the case.

The cane mosaic is not inherited through the true seed, but it has been carried around the world in infected stalk cuttings which constitute the usual planting material. It is not communicated by ordinary contact, but it is freely spread in the field from plant to plant by punctures of *Aphis maidis*, one of the common plant lice usually feeding on corn and various grasses. Numberless attempts have been made to implicate some of the cane leaf hoppers as carriers, but so far without success. No infection of the soil occurs.

Mosaic can be characterized as an infectious chlorosis since its most conspicuous effect is the mottling of the leaves with lighter-colored, whitish, or yellowish-green areas where the chlorophyl has been partially destroyed. This loss of chlorophyl causes nutritional disturbances and usually the pronounced dwarfing of the plant. With a few particularly susceptible varieties, attacked plants are sometimes actually killed. This, however, occurs but rarely, the infected plants

usually living on year after year but yielding scanty and unsatisfactory crops. A somewhat similar mottling can often be seen on the young stalks. As these mature, the internodes become more or less shrunken and the epidermis over the discolored areas dries down and finally cracks and breaks away, leaving the so-called stem cankers. Similar groups of diseased cells are scattered through the central tissues of the stalk. These cause no surface symptoms but they finally die, leaving small empty cavities which account for the lack of juice and light weight of infected stalks. In its earlier stages the disease does not seem to affect the quality of the juices. In fact, early in the season, diseased canes may even be richer in sucrose than adjoining healthy ones, since the lack of chlorophyl tends to hasten maturity. Later in the season, however, cankered stalks where the inner tissues are exposed are frequently attacked by various rot organisms which quickly lower the sucrose and purity. For the most part, losses from mosaic are due to losses in tonnage and in juice yield, rather than to chemical changes in the juice.

The amount of damage caused by mosaic will depend on many factors, including the variety, the amount and distribution of the rainfall, the richness of the soil, the amount and character of fertilizer used, and the kind of cultivation given. In Porto Rico, carefully compiled statistics of sugar production at all of the mills for the years 1917 to 1919, when divided into districts corresponding to the extent of infection, showed that in the non-infected eastern district production in 1919 was somewhat in excess of 1917. In the heavily infected western district, however, average yields had fallen 40 per cent below those of 1917. These losses could only be accounted for as due to the effect of the disease. In some of the worst infected districts, average cane yields per acre had fallen from 28 tons to 8 tons, and in one district to as little as 5 tons. On the other hand, an instance is recorded of a field of fall plant cane on the irrigated lands of the south coast which, though 90 per cent infected, gave a yield of 51 tons per acre. This field, of course, had been well fertilized and cultivated and represented what may be considered optimum conditions. This same field, however, in previous years and with similar cultivation, but before the mosaic outbreak, had often given as high as 65 tons per acre, the mosaic, even under these most favorable conditions, being responsible for a loss of about 20 per cent. Again, on the north coast of Porto Rico in a field of old, heavily infected ratoons, production under current methods of cultivation had fallen to 5 tons per acre. This field was off-barred deeply after the crop had been cut, and was given a double dose of a complete fertilizer, after

which it was given good implement cultivation and two or three irrigations. Before closing in, it was given an added application of sulphate of ammonia. Although 95 per cent infected, production jumped to 25 tons per acre. True, the same treatment would have given at least 40 tons if the cane had been free from mosaic, but the experiment shows that even heavily infected cane will respond to better cultivation, and especially to heavy applications of nitrogenous fertilizers. The effects of the disease are always much more serious on old, poor lands and especially in seasons of severe drought.

At the Cuban Experiment Station the following experiment was tried to test actual losses from mosaic. Two plots were planted in the same field, one with healthy seed and one with mosaic-infected seed, both of Crystalina cane. The two plots were separated by a wide planting of the immune Uba cane as a barrier. The following results were obtained:

Plant Cane Crop of 1925	Mosaic Seed Yield 4509.5 Pounds	Sound Seed Yield 12173.5 Pounds	Difference 7554.0 Pounds	Per Cent of Loss 61
1st ratoons crop of 1926.....	1322.1 pounds	8321.75 pounds	6999.65 pounds	84

These losses are certainly startling, but they are no greater than those that have frequently occurred in commercial plantings in many parts of the world. It is such losses as these that have forced the abandonment of the planting of susceptible varieties in Natal, Argentina, the west coast of Porto Rico, and now Louisiana.

After this brief presentation of the more salient points in the mosaic situation, we may now take up its consideration more in detail, beginning with a brief historical review.

Mosaic was first noted in Java some thirty years ago (1892), where it was called "Gele Strepenziekte," or, as literally translated by Hawaiian writers, "yellow stripe disease." The name was unfortunate since there is seldom any pronounced striping of the leaves but rather a speckling or mottling in confused broken patterns. It was considered a disease of minor importance and its true nature was not suspected. Even the fact that it was infectious was overlooked, although detailed experiments given by Wilbrink and Ledeboer (1910) show clearly that a certain amount of secondary infection was actually taking place. No attempt was made to explain the increased number of cases that were recorded for some of the plots. Conditions

in Java do not seem to have favored the rapid spread of the disease by secondary infection, and it was being controlled by the seed selection and special cultural practices used in combating sereh. Under these circumstances no serious losses from mosaic occurred in Java. It was common enough, however, to have attracted the attention of a number of the experiment station workers, all of whom seem to have considered it a deterioration or an abnormal bud sport. Its contagious nature was not recognized there until after the publication of convincing proof from Porto Rico and from Washington.

The disease next attracted attention in Hawaii (1908) where it was early recognized as the "Gele Strepenziekte." Here too, it was considered as of only secondary importance, and at first the idea that it was a non-infectious abnormality was accepted. Later (1917) Lyon characterized it as "an infectious chlorosis akin to the mosiac disease of tobacco," being thus the first to recognize its true nature. The disease has never taken on epidemic form in Hawaii but it has continued to be more or less troublesome and it is probably attracting more commercial attention to-day than at any previous time.

In 1917, Stevenson, at that time pathologist of the Insular Experiment Station in Porto Rico, published in *Phytopathology* a long account of what he considered to be a new sugar-cane disease. It was causing serious damage in the cane fields along the north and west coasts of the island, all the way from Arecibo to Mayaguez, and it was spreading rapidly. He characterized it as "an epiphytotic." Even this did not suggest to him that he was dealing with an infection. At that time he had not seen the Javan literature, but he too tried to explain what he called the "mottling disease" as a degeneration or abnormality. He concluded that the Rayada cane was "running out." His paper attracted the attention of Lyon, in Hawaii, who at once wrote (12/20–1917) to Director Colon of the Insular Station, calling attention to the fact that the new "mottling disease" was clearly the same as the "Gele Strepenziekte" and that it was now authentically recorded from Hawaii, Fiji, Australia, New Guinea, Java, the Philippines, Egypt, Cuba, and Porto Rico, and characterizing it as "an infectious chlorosis akin to the mosaic disease of tobacco." This important letter was published by Colon in his annual report as director of the Insular Station for 1917–18. It really constitutes our first authentic information concerning the disease.

Since this letter was written it has been established that it was an epidemic of mosaic disease that caused the "running out" of the Ribbon and Purple Canes in Argentina and their complete replace-

ment by the tolerant POJ 36 and POJ 213; and that, still earlier, it was a similar outbreak in Natal which forced the adoption of the immune Uba as the standard cane of that district. Severe outbreaks have also been noted in India, Formosa, Louisiana, Santo Domingo, Haiti, the British West Indies, and Peru, so that now the distribution of the disease is practically world-wide, there being only a few small, isolated cane-growing regions where it has not been reported.

The damages being caused by mosaic were sufficiently discussed in the opening paragraphs. There can be no question whatever that the disease is causing tremendous losses to the industry, yet there are many growers who still refuse to admit the obvious facts, and who fail to take advantage of the well-known means for keeping it under control.

Besides the leaf markings and stem cankers by which the disease can be so readily recognized, anatomical and cytological studies disclose other differences in the tissues of diseased and healthy plants. These differences are for the most part confined to the discolored areas, the tissues of the green areas being practically normal. In the light-colored leaf areas the cells average slightly smaller than in healthy tissue. The chloroplasts are smaller and fewer in number, but the nuclei are conspicuously enlarged and often irregular or distorted. Peculiar intracellular bodies, such as have been described with other mosaic diseases, are occasionally found but they are not common. They seem to be naked protoplasmic masses which vary greatly in form and size. They are often, but not always, attached to the nuclei.

The cavities so frequently found in diseased tissue, both of the stalk and of the leaves, all seem to be formed by the dissolving and breaking down of the cell walls. The nature of the intracellular bodies so often observed in mosaic tissues is absolutely unknown. Some observers have inclined to consider them as in the nature of living plasmodia, but others regard them as degeneration products. The most striking characters of the diseased tissue are the enlarged and distorted nuclei and the greatly shrunken chloroplasts.

It can always be noticed that the usual symptoms of mosaic are much more conspicuous in young, actively growing plants than in old and mature ones. In old fields where the cane is yellow from drought and age, and especially when the leaves are spotted from insect punctures, it is sometimes difficult to distinguish mosaic cases, and this often leads observers to erroneous conclusions. Even under these conditions the characteristic mottling can be detected in the youngest leaves, especially those still enrolled in the bud spindle.

Physiological disturbances causing chlorosis also often produce a condition that may be mistaken for mosaic. Many of the so-called "cures" of mosaic that have been reported in popular cane literature have doubtless been based on cases of chlorosis. Such a confusion can only result from ignorance or from carelessness in observation, for cases of chlorosis never show the peculiar mottling which is so characteristic of mosaic. One form of chlorosis, it is true, the so-called Pahalla blight, does make a conspicuous striping of cane leaves, but these are long, clearly marked, regular stripes, sufficiently distinct from any pseudo-striping that may be caused by mosaic.

A few cases have been recorded by competent observers where mosaic symptoms have disappeared, and attacked plants have apparently recovered. Unfortunately, studies on these cases never seem to have been carried far enough really to demonstrate whether these cases represent real recoveries or unusually well-marked instances of that masking of symptoms that normally occurs as plants reach maturity. The question is interesting but of little practical importance. If recoveries ever occur it is so seldom that, for all commercial purposes, we may consider that mosaic is absolutely incurable and that plants once attacked will always be diseased.

Cuttings from infected plants germinate freely but always produce diseased plants. The infection can usually be detected in the third leaf produced by the germinating bud. Occasionally, however, it is masked for a time and does not manifest itself until somewhat later. In cases produced by artificial inoculation in the terminal bud spindle, it has been observed that basal suckers develop the symptoms of the disease almost as soon as the new terminal leaves, thus showing that the infective principle is freely carried by the sap to all parts of the plant, but it is only the young growing tissue that are susceptible. The older leaves, those formed before the inoculation, never show mosaic symptoms. Cuttings taken from the lower part of such stalks, however, will quite certainly develop the disease. Even cuttings from stalks in the same stool, which have themselves never shown mosaic symptoms, may germinate with the disease, showing that the contagion is carried to new forming buds wherever there is an organic connection which permits the sap to circulate. It only passes, however, where such organic connection exists, since it is not communicated through the soil nor by casual contact. Two cuttings, one diseased and one healthy, have been planted in the same pot in the greenhouse and have grown side by side for months, the one diseased and the other remaining healthy. As has been stated, it is in such infected cuttings that the disease has been carried to prac-

tically all parts of the world, and the careless planting of such material is still rapidly extending it into new farms and districts.

Once a few diseased seeds have been planted in a field, the mosaic begins to spread to adjoining healthy stools by what has come to be called secondary infection, primary cases being considered as those coming from infected seed or infected ratoons. The rapidity of this secondary spread varies widely according to local conditions. Sometimes it is very rapid, but occasionally it spreads very slowly, the disease remaining almost stationary for considerable periods. It is sometimes difficult to account for this difference in behavior, but, ordinarily, the disease spreads fastest when conditions are such as to cause the rapid growth of the young cane. Field studies in Porto Rico (1918) strongly indicated that the disease was insect-carried, and that the secondary infection was being caused by the punctures of some sucking insect. Determined efforts were made to solve this question, numerous cage experiments being tried with all the sucking insects found feeding on cane, but with no conclusive results. Finally (1920) Brandes was able to determine in the greenhouses at Washington that it was transmitted by *Aphis maidis,* an insect common on corn sorghum and various grasses. This was acclaimed by the workers in Porto Rico as a big step in advance and as confirmation of their theory that the disease was insect carried, but they felt that it did not explain what was happening in Porto Rican cane fields since none of them had ever seen *Aphis maidis* on a cane plant, notwithstanding the long and diligent search for possible insect carriers. Finally, in a field on the south coast where workmen were hoeing some tall grass out of a young cane field, Wolcott observed numbers of *Aphis maidis* leaving the wilting grasses and climbing up the young cane. With this as a clew, Chardon and Veve (1922) were soon able to demonstrate that this and a closely related aphid normally feeding on nut grass were the real carriers of mosaic, even in Porto Rico. It is a most remarkable fact that so serious a disease can be spread so rapidly by an insect that does not normally feed on the cane plant. No similar case has been recorded in the literature of disease transmission by insects. There can, however, be no question as to the facts. They have been abundantly verified by competent workers in other countries, and so far no other insect carriers have been detected. Secondary infection usually takes place in the immediate neighborhood of diseased plants, each one of which acts as a center from which the disease spreads in irregular concentric circles. Even a roadway or a wide ditch may act as a partial barrier. At other times, however, the infection seems to leap for long dis-

tances, suddenly appearing in new localities several miles distant from any known case of the disease. At first it was assumed that these long-distance infections must be caused by some other stronger flying insect, but recent studies on the dispersal of the winged form of the aphis make it seem probable that these cases too are caused by the same species.

Naturally, attempts have been made to transmit the disease artificially. This has been done successfully by a number of investigators in different countries, but always with a certain amount of difficulty and uncertainty. This is remarkable in view of the ease with which many of the other mosaics may be transmitted. These contradictory results are probably due to the fact that only young, actively growing tissue seems to be susceptible, and that plants must be making an active growth in order to take the disease readily. Cases have been induced by inoculation with infected juice, by dropping bits of diseased tissue into the enrolled terminal bud spindle, and by binding tips of diseased canes into slanting cuts near the tops of other canes (in the manner of making a side graft). With all these methods, however, failures have been more frequent than successes. The method recently described by Bonazzi (1926), of inoculating seed pieces by opening a hole just below the bud with a small cork auger and filling it with diseased tissue, seems much more promising as a means of testing the resistance or susceptibility of new varieties.

One of the most remarkable things in connection with sugar-cane mosaic is the strikingly different behavior toward it of different cane varieties, and especially of different races. As has been already stated, the noble canes belonging to *Saccharum officinarum* are, so far as we know, all susceptible; the Chinese canes, *S. sinense,* are either immune or highly resistant; the wild canes, *S. spontaneum,* are also immune; while the North Indian canes recently referred by Jeswiet to *S. Barberi* are fully susceptible but very tolerant, being scarcely injured by the presence of the disease. The varieties of these different races, while agreeing with each other in a general way, are by no means uniform in their reactions. The noble canes vary considerably among themselves in the extent to which they are injured by mosaic and in the character of the markings on the leaves. In some cases the mosaic pattern may even be used as a diagnostic character by which to determine varieties. The Chinese canes, too, vary considerably in the completeness of their immunity, and the North Indian canes in the extent of their tolerance. It is noteworthy that the characters of tolerance and immunity are usually dominant in hybrids. Varieties with as little as one-eighth of *S. spontaneum*

blood often show pronounced resistance to mosaic. This is a matter of great importance for the plant breeder.

Sugar-cane mosaic is not confined to species of the genus *Saccharum*. It is also known to attack corn, sorghum, and various grasses, and by means of infected aphids it may be transferred from these hosts to cane or *vice versa*. Doubt has been thrown on some of the cases reported in the literature since it has recently (1927) been shown that there are two kinds of mosaic on corn, one of which can be transferred to cane and the other not. Brandes and Klaphaak (1923) record the successful inoculation of the following species by means of aphids infected by feeding on mosaic cane; these at least, therefore, seem to be well authenticated as additional hosts:

Corn	*Zea Mays*, various varieties.
Sorghum	*Holcus Sorghum.*
Pearl millet	*Pennisetum glaucum.*
Eulalia	*Miscanthus sinensis.*
A wild sugar cane	*Saccharum narenga.*
Bull grass	*Paspalum bosacianum.*
Crab grass	*Syntherisma Sanguinalis.*
Yellow foxtail	*Chaetochloa lutescens.*
Giant foxtail	*Chaetochloa magna.*
Barnyard grass	*Echinochloa Crusgalli.*
Panicum	*Panicum dichotomiflorium.*
Brachiaria	*Brachiaria platyphylla.*

Some of the above grasses are common weeds in cane fields. The possibility of other farm crops and of cane-field weeds becoming infected of course complicates control measures; still, it seems that the danger of infection from these other hosts has been rather overstressed. The great majority of all outbreaks of mosaic in cane can be clearly and certainly traced to other diseased cane, and the presence of the disease in other hosts has not prevented its complete control by the method of eradication to be discussed in the following paragraph.

We now come to a consideration of methods of prevention and control. This is, of course, the practical end aimed at in all studies of plant diseases. The treatment of diseased plants is useless. No topical applications or remedies of any kind have been found which are of the slightest use. The contagion is protected within the living tissues of the plant and cannot be killed by applications that do not also kill the cane. So far as we know, it does not exist outside of

the living plant tissues, except as carried by the insect vectors. When the plant tissues die the virus dies also. The soil does not become infected. Whether the insect carrier acts as an intermediate host, as is the case with some insect-borne diseases, or whether it simply carries the living contagion from one plant to another, has not been determined. Since, then, the only known sources of contagion are living diseased plants, the obvious method of control is by eradication, by the pulling up of all diseased plants. Where the percentage of infection is small this method is perfectly feasible and comparatively inexpensive. It is being practiced with complete success wherever it has been tried thoroughly and carefully, even in heavily infected districts, but half-way measures always fail. Of course, this method is not practicable in old fields that are heavily infected. The only thing to be done in such fields is to cut such crops as they give, as long as it is profitable to do so, and then to plow them up and destroy them. It is sometimes difficult to say just where to draw the line and to determine whether to attempt to eradicate the disease or to abandon and plow up the field. No one need hesitate to undertake eradication when the infection does not exceed 15 or 20 per cent. The cost of doing the work and of filling in the vacancies will be much less than that of planting a new field. In cases where there is a shortage of healthy seed, it will often pay to go much farther than this in cleaning up fields to be used as seed. Digging out one-half, or even three-fourths, of the stools would be perfectly justifiable if a seed supply could be secured in no other way. Beginning with a supply of clean, healthy seed is a first requisite in a campaign of eradication. In some countries, as Java and Hawaii, seed selection alone has served to hold the disease in check and to prevent it from assuming the proportions of an epidemic; but in most countries, and especially in heavily infected districts, this must be considered as a first step only, and must be followed up by frequent inspections of the new fields for the roguing out of all diseased plants. Even with the greatest care in seed selection, an occasional infected seed will be planted. If these are hunted out and removed as soon as the disease can be detected, no great harm will have resulted; but if they are allowed to remain, each one of them will become a center of infection which will sooner or later involve the whole field. Then, too, in infected districts occasional cases of secondary infection will appear where the disease is brought in from the outside by infected aphids. The only safety consists in repeated roguings until such time as the cane closes in and can no longer be inspected. After the field has been harvested the work must be continued in the ratoons.

In fact, inspecting for and roguing out mosaic must become as much a part of the routine plantation work as the hoeing out of grass. This requires care and watchfulness and involves a certain amount of expense, but it is in the nature of an insurance against the much heavier losses that are sure to occur if the field becomes heavily infected. This method of mosaic control by seed selection and eradication is being widely and successfully practiced in many countries, notably in Porto Rico, Jamaica, and some parts of Cuba. The disease was discovered in Louisiana and in Florida at about the same time, in 1919. In Florida the State Plant Disease Board, which had been granted ample powers for eradicating citrus canker, took up cane-mosaic eradication also, and so successfully that within a few months' time the disease was not only under control but completely stamped out. This is one of the few cases on record where the disease has been actually exterminated by eradication measures. In Louisiana, however, nature has been allowed to take her course, with the result that infection has become complete in practically all parts of the state, and the industry in consequence is passing through a most serious crisis. The cost of eradication naturally depends on the price of labor. In one large plantation in south Porto Rico where every field has been carefully inspected and rogued since 1919, the average cost has been about 50 cents per acre a year. The measures taken have been completely successful in keeping infection down to a negligible minimum. In Cuba, where labor costs are higher, available figures indicate an average cost of about a dollar an acre per year as the expense of keeping mosaic under complete commercial control, sufficient to permit of the planting of the most susceptible varieties. This does not refer to plot experiments but to large plantation areas. Unfortunately, only a few, even of the larger companies, are following such enlightened methods. The futility of depending on seed selection alone is shown by the experience of a large company in central Cuba which, during the spring of 1924, planted 50,000 acres of new cane, all of it in more or less infected districts. This was all planted under the colono system, so that complete control was difficult. A great effort was made to secure healthy seed for this big planting, but, as it germinated, actual counts showed that the seed had carried an average of ½ per cent of infection. About 90 per cent of these colonos followed instructions and rogued their fields carefully, with the result that they were closed in with less than 1 per cent of mosaic, an amount commercially negligible. The other 10 per cent of the growers flatly refused to pull up any of their cane. These fields closed with from 50 per cent to 90 per cent of infection

although it is absolutely certain that they were planted with only ½ per cent of infected seed.

Another possible method of mosaic control, which is theoretically attractive, would consist in destroying the insect carrier. If there were no aphids there would be no spread by secondary infection. The control of an insect like *Aphis maidis*, however, presents serious practical difficulties, and it is hardly possible on a field scale. Something can be done by avoiding the planting of crops like corn and sorghum in the immediate neighborhood of cane fields, since they serve as nurse crops for the breeding of aphids on a large scale. Clean cultivation between the rows and on the sides of the field, to avoid growing grasses to serve as nurse crops, is also useful. Farther than this we can hardly expect to go. The expense of trying to control mosaic through aphis control would be too great to be practicable.

Another completely successful way of controlling mosaic is through the substitution of immune varieties. This was done on a large scale many years ago in Natal, where the immune Uba completely replaced the susceptible kinds that were formerly in cultivation. This was long before mosaic had been recognized as a specific disease. The usual formula, that the kinds in cultivation had "run out," was accepted. Immune varieties were also used extensively in western Porto Rico, where the Kavangire cane, imported from Argentina, was widely used to replace the diseased Rayada. This was the first cane in which immunity to mosaic was clearly demonstrated. Unfortunately, through an error, it came to be widely known as Uba in Porto Rico. Although closely resembling that well-known kind, it is clearly distinct from it. Both are strong-growing canes which give high tonnage even on poor lands, but they are very late in maturing, making it difficult to base an entire crop on them, and they are so slender in diameter and shed the trash so poorly that they are more difficult and expensive to harvest. Unfortunately, we as yet have no immune kinds that are fully satisfactory commercially, and until such are produced it is better to consider the use of immune kinds as in the nature of a temporary makeshift in highly infected districts, until such time as the fields can be sufficiently cleaned up to permit of controlling the disease by eradication. In fact, this is just what is happening in western Porto Rico. Kavangire was planted very extensively from 1919 to 1922, but high-sucrose canes like BH 10(12) and SC 12(4) are proving to be so much more profitable that they are rapidly replacing Kavangire in the same fields that showed 90 to 100 per cent mosaic in 1918.

A third method of meeting a serious mosaic situation consists in substituting tolerant varieties, like the early members of the POJ series from Java, in place of the usual susceptible kinds. This was widely done in Argentina long before it was known that it was mosaic that was causing the "running out" of the older kinds. POJ 36 and POJ 213 are the kinds mostly planted there, and, though they are a full 100 per cent infected with mosaic, they continue to make satisfactory yields. POJ 36 and POJ 105 have been planted to some extent in western Porto Rico, and now a determined effort is being made to solve the trouble in Louisiana by following the same lines. Here it is POJ 234 that is being mostly planted. This method is in no sense a control of mosaic. It is continuing to propagate the disease, but it does provide a way for continuing the commercial production of sugar from fully infected fields. It is not, like the planting of immune kinds, a step toward ultimate disease control.

When the plant breeders have succeeded in giving us a fully satisfactory immune cane, we may safely adopt the easier way of planting it and of discarding all of the susceptible kinds. When that day comes, mosaic will cease to be a cane-field problem. Until that time, however, planters are strongly urged to take the situation firmly in hand, and adopt those eradication measures that will enable them to plant any of the best commercial kinds.

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The Root-disease Complex.—The trouble, or perhaps we should say the series of troubles, to be dealt with under this heading is fully as serious as the mosaic, but it presents a very different problem and requires completely different methods of control. In mosaic we were dealing with a clear-cut disease caused by a specific parasite or virus which, so far as we know, occurs in nature only within the tissues of living plants and which can be transferred from one plant to another through the agency of sucking insects. Clearly, control rests in destroying infected plants and thus avoiding sources of contagion. In root disease, however, we are dealing with the combined action of various unfavorable environmental factors which so lower the vigor of the cane plant as to permit of the attack of some one of several weak facultative fungous parasites that are everywhere present in cultivated soils. Both factors are necessary to induce the disease. The fungi are unable to attack plants that are in full vigor. The unfavorable environmental factors alone, while they would reduce yields, could not induce root disease without the aid of the facultative parasites.

The usual symptoms of root disease are those of physiological drought. The plant shows signs of stress during dry weather. Finally the leaves begin to roll during the middle of the day. The

lower leaves dry up prematurely, or, as we say, the plant shows signs of firing. A tip burn of the leaves often occurs. In severe cases there may be a top rot caused by the death and decay of the terminal bud. Finally the entire stalk becomes infected with the rind disease fungus (*Melanconium*) and thus becomes a total loss. This stage is usually followed by the death of the stool, and the field becomes spotted with bare areas or "sabanas" where the disease has been most serious.

Now, many of those same symptoms may arise from other causes. It makes little difference in the effect on the plant whether the roots are rotted off by *Pythium* and *Rhizoctonia* or whether they are eaten off by insects or other animal pests. Snails, centipedes and nematodes are all accused of doing such work. In Cuba a root mealy bug has been found. In Porto Rico and Australia great damage is caused by white grubs of various species which eat the cane roots. Wireworms often do serious damage. The symptoms of the vascular-bundle disease (*Plasmodiophora*) in Porto Rico are very similar to those of root disease. Salt or other toxic chemical substances in the soil may produce quite similar injuries. We shall avoid much unnecessary confusion if we restrict the term root disease to those cases where there is an actual rotting off of the roots, referring all these other root injuries to their proper causes. It must be remembered, however, that all of the above may, and in fact usually do, act as inciting causes for root disease proper. Injuries of these kinds, even when not sufficiently serious to endanger the plant if acting alone, serve to reduce its vigor sufficiently to permit the attack of these root-destroying fungi.

The inciting causes which may lead to root disease are many and varied. This is why it is so often referred to as a disease complex instead of simply as a disease. The numerous root-eating insects and other pests have just been referred to as among the causes which so weaken the plant as to break down its resistance to facultative fungous parasites. For a clear understanding of root disease one must fully grasp the difference between facultative parasites and obligate or true parasites. This difference is not always made sufficiently clear, even in works on plant pathology. The first group are normally saprophytes living on dead organic material, but they are able to attack feeble tissues that are lacking in vigor even while they are still living. The true parasites, on the contrary, as a rule grow best in the most vigorous, actively growing host tissues. Many of them cannot grow except in the living tissue of their special host plant.

Mosaic is another frequent inciting cause of root disease. It dis-

turbs the nutrition of the plant and so lowers its vigor that the roots can no longer resist the attacks of *Pythium* and *Rhizoctonia,* which are everywhere present in agricultural soils. It is usually these organisms, fully as much as the primary effect of the mosaic, that so often lead to the early abandonment of heavily infected fields.

Many times, especially in dry districts, there is an undue accumulation of salts in the soil. This may be either sodium chloride alone or this salt in combination with sodium sulphate and sodium carbonate, the salts usually found in alkali soils. When such an accumulation amounts to as much as ½ per cent or more, most cane varieties are likely to be severely injured where they do not actually die. This could hardly be called root disease, but a lower concentration of these toxic salts may so weaken the cane as to permit the rotting of cane roots. In such cases no other name can properly be applied.

On strongly alkaline limestone soils, cane often develops a serious chlorosis. If no complications occur, it usually completely recovers after a time. If, however, while in this weakened, chlorotic condition the roots are attacked by *Pythium* or *Rhizoctonia,* a true case of root disease will develop.

Various workers have shown that on certain soils corn is subject to a root disease that seriously stunts its growth, and that this condition is accompanied by the deposit of salts of iron and aluminum in the nodal tissues of the stalks. McGeorge and others have shown (1924) that a similar condition exists with cane in Hawaii. Here again, this condition could hardly be called root disease but it might easily be an inciting cause. In fact, as we shall see later, many of the worst outbreaks of root disease occur on very heavy, compact clay soils. It has been supposed that the root trouble came from their very compact physical condition, but quite possibly this chemical factor also needs to be considered.

Root-disease trouble may also often come from soil exhaustion and the lack of proper fertilization to correct it. If the amount of any one of the food elements in the soil solution becomes too small, a lack of vigor ensues which will quite certainly permit of the rotting of the roots. Probably it is the lack of available nitrogen that most frequently brings this about. On the old red lands of the West Indies, however, it is clear that this condition is caused by phosphoric acid starvation. These lands are high in iron, which tends to hold the phosphoric acid in insoluble compounds, and though their physical condition is unusually good, they frequently suffer from root disease, a condition that is quickly corrected by proper fertilization and tillage.

A considerable number of contributory causes for root disease have

already been indicated. Doubtless the list could be considerably extended, but the fact would remain that the great majority of cases are caused by bad physical condition of the soil resulting in lack of aeration for the roots. Like all living things, cane roots must have oxygen in order to function properly. If the soil is unduly compacted or heavily crusted, the supply is interfered with. If the soil becomes water-logged for even a few days trouble is almost certain, for cane is not an aquatic and its roots cannot take their oxygen supply from water. Probably lack of drainage is responsible for more cases of root disease than all of the other factors combined. Standing water, for even a few days, is almost certain to weaken the roots. The effects will probably not be observed until the first sharp drought, when the rolling of the leaves and other symptoms of root disease will appear in all the spots where there has been standing water. Obviously, such cases could be avoided by proper drainage, especially if accompanied by prompt tillage as soon as possible after heavy rains, to break up surface crusting and to open up the com pacted soil so as to permit the air to enter freely.

On the other hand, soils may be too loose and open to permit the healthy growth of cane roots. Trouble is quite likely to appear in spots in fields where there are banks of coarse sand or heavy gravel. Too much air, with the consequent drying out of the rootlets, may be as bad as too little.

As with most other cane troubles, we are soon forced to observe that there is a great difference in cane varieties, and especially in cane races, with respect to their resistance and susceptibility. Here again, it is the noble canes that are most susceptible while varieties of the other three races show varying degrees of resistance or almost immunity. We are waiting for the plant breeder to give us the ideal variety that shall combine the best qualities of all these races. Even among the noble canes, however, as we know them to-day, there is a marked difference in resistance and susceptibility. The old favorite, Otaheite, is one of the most susceptible of all of them. While well adapted to rich virgin lands, it seems to have a weak root system that is unable to resist the unfavorable conditions as soils become old and compacted. It is with this variety that the most serious and spectacular losses have always occurred. Root disease is the controlling factor that has compelled the abandonment of this exceedingly popular kind in practically all parts of the cane-growing world. It has usually been replaced by Crystalina or its color variant, Rayada. These are much hardier canes and resist bad soil conditions much better, but they, too, are running down in one country after another

as the soils get older and more exhausted. They are being replaced by various newer seedlings that show more resistance to these conditions. Just now in Java it is the EK 28 that is being most planted. In Hawaii H 109 is a strong favorite. In the West Indies BH 10(12) and SC 12(4) are rapidly replacing most other varieties, but this is largely because of their better tonnage and high sugar content rather than because of root-disease resistance. As a matter of fact, they are but little better than Crystalina in this respect and are only proving to be adapted to the better lands. Indications are not lacking that all of these present-day favorites will in turn soon be replaced by some of the newer hybrid seedlings, like the later series of the POJ canes, which carry some portion of the wild blood to give them greater hardiness.[1]

The fungus factors connected with root disease have so far been only incidentally mentioned, but it will be better to defer their further consideration until after a brief review of its history in the literature. No cane disease has been more widely observed and discussed, but none seems to have been so poorly understood. Even the discussion of the fungi connected with its various stages has been involved in needless errors.

Although positive proof is usually lacking, there is good reason to believe that many of the noteworthy outbreaks of disease which have in the past caused serious crises in the sugar industry were really due to these root troubles. Such a crisis occurred in the islands of Bourbon and Mauritius as early as 1846. The outbreak in the Mayaguez district of Porto Rico in 1872 was quite clearly a similar case, though here perhaps complicated by the vascular-bundle disease. In Cuba and the British West Indies the crisis was never as acute as in these two cases, but root disease just as certainly compelled the abandonment of the Otaheite cane. In Java the problem was complicated by yellow stripe disease and sereh, but the prevailing custom of taking no ratoon crops can probably be traced to root disease quite as much as to the economic necessity of guarding the use of the land for food crops.

Wakker, in Java, seems to have been the first (1895) to attempt to assign a specific cause for root disease. He found a small gill-fungus or mushroom growing on the trash at the base of the diseased stalks. He named it *Marasmius sacchari* and assumed that it was the real cause of the trouble although he submitted no proofs to show

[1] Persistent reports are coming from Java that this long-expected super variety has been found in POJ 2878, a kind carrying one-eighth of wild blood. This is being planted so rapidly that it promises to become the chief commercial kind within a very few years.

its causal relationship. His work has been widely accepted and followed, and to this day most writers use the words *Marasmius* disease and root disease interchangeably.

During the years 1899–1902, Albert Howard was investigating sugar-cane diseases in the West Indies for the Imperial Department of Agriculture. He found and identified *Marasmius sacchari* on cane in Barbados and seems to have been the first to recognize the West Indian trouble as being the same as that in Java. He attempted some experimental work, but just what it was is not clearly stated. The results, however, served to convince him that Wakker's assumption was correct and that the *Marasmius* was the real cause of the trouble. In this he has been followed by Lewton-Brain, Bancroft, Tempany, Stockdale, and other British workers in the West Indies.

Cook and Horne were investigating root disease in Cuba, beginning with 1904. They found abundant mycelium of what seemed to be *Marasmius,* but no fruiting bodies were observed until 1908 when they were abundant not only on cane but on Johnson grass, Para grass and Guinea grass. They also found another Hymenomycetious fungus, at first considered to be *Peniophora sp.* but later referred to as probably *Hypochnus sacchari.* They inclined to consider this rather than the *Marasmius* as the true cause of the disease, but no experimental evidence was given.

In Hawaii, in 1905, Lewton-Brain published an account of a root disease which he considered identical with the one previously known by him in Barbados. He found *Marasmius*-like mycelium but no fruiting bodies. These were found the next year and were called *Marasmius sacchari* var. *Hawaiiensis,* by Cobb (Sugar Sta. Bull. 5, 1906). In this same publication Cobb described and fully illustrated a stinkhorn fungus, *Ithyphallus coralloides* n. sp., to which he ascribed the principal rôle as a cause of cane-root disease. The discussion was not supported by a single word of experimental evidence, and, as it has not since been confirmed, this elaborately illustrated paper can only be considered as one of the curiosities of pathological literature. No fungus would be less likely than this one to cause a serious plant disease.

In 1908, root disease was discussed by Fulton in Louisiana. He attributed the trouble to a *Marasmius* but considered it to be *M. plicatilis* Wakker, rather than *M. sacchari.*

In Porto Rico, root disease was extensively studied by both Johnson and Stevenson. In their joint paper on sugar-cane fungi and diseases (1917), they enumerate and describe *Marasmius sacchari* Wakker, *Himantia stellifera* Johnson n. sp., *Odontia saccharicola*

Burt, and *Odontia sacchari* Burt as occurring on the base of cane stalks and apparently in connection with root disease. They say, however, "The exact status of root disease with respect to the parasitism of *Marasmius, Himantia, Odontia,* or possibly other forms, is uncertain, and while it is generally held that *Marasmius* at least is a true parasite, really definite evidence is lacking."

In the Hawaiian Planters' Record, July, 1919, Lyon published and figured an organism which he assigned to the Chytridineae and which he considered "the primary cause of the Lahaina disease (of cane) and of pineapple wilt throughout these islands." Sporangia and large, thick-walled resting spores were found singly in the soft parenchyma cells, often near the root tips. The sporangia quickly produced motile zoospores, but the resting spores had failed to germinate after some months of observation.

Later in the same year, Carpenter, of the Federal Experiment Station in Hawaii, also published a paper on root disease, in which he attributed the trouble on cane, taro, bananas, rice, and pineapples to a species of *Pythium* which he considered as probably *P. DeBaryanum.* He discussed Lyons' paper and claimed that the resting spores figured by Lyons were in reality the resting spores of this *Pythium.*

Carpenter was not the first to note the presence of *Pythium* in the roots of cane. In 1885, Treub in Java (Med. Slands Plant, Buitenzorg 2:20–35), in a paper on sereh disease, referred at some length to the presence of *Pythium* in the roots and suggested it as a possible cause of sereh. In 1896, Wakker, in a paper entitled "De Schimmels in de Wortels van Het Suikerriet" (Med. Proefs. Oost-Java. 21.), gave a fine plate and a long description of *Pythium* as the cause of the killing of cane roots. Later, the more conspicuous *Marasmius* seems to have attracted his attention more strongly and we find no further mention in the literature of *Pythium* as a cane fungus until its rediscovery by Carpenter as noted above.

Matz's studies of root disease in Porto Rico were begun in 1918 but were not published until 1920 (Jour. Dept. Agr. Porto Rico, 4(1):28–40). His numerous observations and experiments showed clearly that in incipient cases of root disease many of the small rootlets showed discolored softened areas, usually at the tips, from which it was easy to isolate pure cultures of *Rhizoctonia* and sometimes of *Pythium,* and that these, when placed in contact with young cane roots, either in water or pot cultures, were able to reproduce similar lesions. He also showed that the pure cultures of *Marasmius* had no such effect, but that the cane roots continued sound even when

involved in masses of the conspicuous white mycelium. Recent publications from both Hawaii and Louisiana confirm the fact that both *Pythium* and *Rhizoctonia* may be cultivated out from young, recently attacked cane roots. These investigators stress *Pythium* as the usual root killer, while Matz found it less often than *Rhizoctonia*.[2] There can be no doubt that either of them can kill young cane roots, at least where conditions are such as to favor their growth and not that of the cane. No evidence has been adduced to show that either *Marasmius* or the other *Hymenomycetes* found on cane roots are ever parasites. They may interfere somewhat with normal growth, but they do not kill roots. Many other fungi have been cultivated from dead cane roots, but no parasitism has been proven for any of them.[3] This remark does not refer to the species of *Fomes* supposed to cause zonate foot rot for that constitutes a distinct specific disease.

One other fungus deserves mention in this connection although it probably has no causal relation to root disease. This is the *Melanconium sacchari* which is everywhere found in abundance forming conspicuous black pustules on dead cane tissues. It constitutes the so-called "rind disease" that at one time played a conspicuous part in sugar-cane literature. As here understood, it is usually only the final expression of root disease, coming in at the end to finish the job, especially in those cases that develop top rot. This fungus evidently has some power as a facultative parasite as it is able to attack tissues that are still living. It also follows cases of top rot caused by the vascular-bundle disease and by borers. Bored joints, even when they do not lead to a top rot, are very often invaded by it. Usually it is confined to the injured internode, but if the stalk is old or feeble it may pass through the nodal tissues and infect adjoining internodes. All tissues invaded by it quickly turn red, and there is an immediate inversion of sucrose. It is the action of this fungus rather than the mere presence of the borer that causes such heavy sugar losses. It also attacks cane that has been cut too long before grinding. The total losses caused by it are often a very serious matter. While probably not implicated as an original cause in root disease, it certainly greatly increases the losses caused by such disease. It also seems to cause a basal or foot rot of the cane itself, a condition which sometimes causes serious losses but which has never been fully investigated. It also frequently causes the rotting of seed pieces in the ground, especially if weather conditions are not favorable. This rotting of seed cane is usually attributed to the so-called pine-

[2] Matz's findings were fully confirmed by Bourne in Barbados (1922).
[3] A *Fusarium* has been found killing cane roots in Florida by Bourne.

apple fungus, *Thielaviopsis*, but there is reason to believe that it is more often caused by *Melanconium*. Cane attacked by the red rot, *Colletotrichum falcatium*, is also quickly invaded by *Melanconium* which, with its more conspicuous pustules, quickly masks the presence of the other fungus.

This important fungus has been involved in many needless and really inexcusable errors in cane-disease literature, at various times having been confused with *Trichosphaeria*, *Thielaviopsis*, *Diplodia*, and *Colletoltrichum*.

Top rot has been mentioned as often resulting from attacks of root disease. This too requires a word of discussion. It cannot be taken as a certain symptom of root disease, since an entirely similar condition may arise from the attack of borers, from the vascular-bundle disease, and probably from other causes. The "top rot" here referred to is a physiological effect due to cutting off the water supply from the roots by any cause. It often results in a stinking bacterial rot of the soft tissues, but at other times they simply dry down. This rot seems to be entirely secondary and to occur only after the death of the tissues. Mention has been made at various times in the literature of a supposed contagious bacterial top rot, but no careful studies of such a disease have been recorded.[4]

We now come to a consideration of remedial measures. In view of the great number of causes which may lead to this trouble, no universal remedy is to be expected. Each case must be studied independently, and its predisposing cause determined. In the case of insect or other root pests, something may be done by direct attacks on the pests. If the trouble originates from something amiss in the composition of the soil, chemical soil amendments are suggested. For very acid soils the remedy may be heavy liming, or, as shown in Hawaii, very heavy applications of phosphoric acid or of potash. An undue accumulation of salts in the surface layers may often be corrected by deep drainage. If the trouble comes from simple starvation, from the lack in the soil solution of some one or more of the necessary food elements, that is easily corrected by proper fertilizing. The great majority of the cases, however, will be found to depend on the poor physical condition of the soil, and here we must call in the agronomist rather than the pathologist. These cases can be quite certainly prevented by better drainage and by reasonably good tillage. The latter is especially indicated in the case of old ratoon fields where the soil has become compacted by the trampling of animals and the wheels of carts in the taking off of successive crops. No

[4] See discussion under Tokkah Bong.

other agricultural crop would continue to flourish under such conditions. Why should we expect cane to do so?

These root-killing fungi are the same ones that cause the damping off of young seedlings. Vegetable growers combat them in exactly the same way that is here recommended. Seed beds are always banked up so as to secure good local surface drainage. Instead of sowing the seed broadcast, as was formerly the custom, modern growers plant them in drills far enough apart to permit of stirring the ground when it becomes crusted, either from rain or continued watering, and this prevents loss from damping off, just as a similar working and aerating of the soil prevents the loss of cane roots. In seed beds, topical applications, to the surface of the soil, of Bordeaux mixture or other fungicides are often resorted to. With cane this would be neither practicable nor effective. We need to guard the cane roots for months and years and not for only a few days as in the case of the seed beds.

The question of variety, too, will have to be carefully considered in localities when there is trouble from root disease. This question has already been discussed. Even in those case which are primarily caused by root-eating pests, different varieties will be found to react very differently. In the chapter on varieties, notes are given under most of the kinds, concerning their susceptibility to root troubles.

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In connection with root disease there are three other minor troubles which should be considered, since they have much the same general symptoms. These are vascular-bundle disease, frog hopper blight, and zonate foot rot.

Vascular-bundle Disease.—In Porto Rico, in many of the cases showing the general symptoms of root disease, the larger vessels of the vascular bundles, especially in the lower part of the stalks, are found to be filled with a yellowish protoplasmic substance which seems to constitute a living plasmodium. Later, it breaks up into thick-walled globular resting spores which are from 14 to 16 microns in diameter. These spores are densely granular and opaque, with a uniform, thick, hyaline cell wall. These resting spores resisted all attempts at germination in Porto Rico, but in Barbados Bourne found them breaking up into four ciliated zoospores. This organism has been named *Plasmodiophora sacchari* by Matz. It seems to be a true parasite, but there is some indication that the soil may become infected. This point, however, has not been fully proven. Ordinarily, the disease is clearly carried in infected seed pieces, but cases where recently bred seedlings have become infected show that there are other methods of infection.

This disease is widely spread in Porto Rico. There is scarcely a field where it cannot be found by a little searching. In many cases it is so abundant as very materially to lower yields. It has also been found in Barbados, but so far it has not been identified elsewhere. From the nature of the disease and the ease with which it can be transported in seed cane, it seems quite certain that it has a wider distribution.

All of the noble canes seem to be susceptible; at least, it has been found in over fifty of them in Porto Rico. As usual, Otaheite is particularly susceptible, and there is reason to suppose that this was one factor of the disease outbreak at Mayaguez in 1872 which so severely injured that variety. Kavangire, and presumably other canes of the Uba type, seem to be immune.

It is unfortunate that the name "dry top rot" has been proposed for this disease. It is true that it quite frequently leads to this condition, but so does true root disease and some other troubles. Even though it causes the drying of the top, the organism is never found there, but only in the vascular bundles and usually near the base of

the stalk. Confusion will be avoided by calling this trouble vascular-bundle disease and not top rot.

No remedial measures have been proposed.

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Frog-hopper Blight: Trinidad Blight.—There are many references in the agricultural literature of Trinidad regarding injury to sugar cane caused by the frog-hopper or spittle bug, *Tomaspis varia* Fabr. Aside from the mechanical injuries and loss of sap caused by the punctures of these insects, a diseased condition is induced which has been widely recognized as frog-hopper blight. The symptoms described agree so closely with those of root disease that it seems probable that the punctures of these insects should only be regarded as another predisposing cause to that widely occurring trouble. It has seemed best, however, to retain this blight under a separate heading until the matter has been more fully studied.

Good cultural methods and the planting of strong-rooted, resistant varieties with some admixture of other than noble-cane blood will probably be more effective than attempting to control the insect.

This trouble does not seem to have been recognized outside of Trinidad.

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Zonate Foot Rot.—Stools are sometimes seen in new timberland plantings that show much the same symptoms as ordinary root disease. The conditions of growth are so favorable on these new lands that no trouble of this kind could be expected. The attacked stools

usually die. The bases of the stalks are found to be invaded by a fungus mycelium which causes peculiar zonate markings. In some cases the fruiting bodies of some undetermined species of *Fomes* have been found on these dead stalks. The presumption is strong that this is the causal organism, although the fact has not been really demonstrated. It seems to be a fungus normally growing on dead roots and stumps, which under certain conditions has sufficient parasitic power to attack and kill sugar cane. The disease seems to be of only minor importance and so far it has only been observed in eastern Cuba. No remedial measures have been suggested.

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Gum Disease.—This is the one major cane disease that, so far as we can determine, originated in America. There is no record of its occurring on anything except sugar cane, but as this is not a native of America it seems most probable that the original host was one of the big grasses of South America. The first report of what we suppose to have been gum disease was made by Dranert, from Brazil, in 1869. The Otaheite or, as it was there called, the Cayania cane was then quite generally planted, and as it is one of the most susceptible to gum disease the industry was seriously crippled. The situation was finally saved by substituting the Cavengirie which, though not fully immune, is much more resistant than the Otaheite. To the present day, notwithstanding its very low sugar content, this is the kind on which the Brazilian sugar industry is based.

Gum disease seems to have been carried from Brazil to Mauritius in 1869 in that same shipment of canes which included the now famous Uba. This is the year that the disease was first reported by Dranert. From Mauritius it seems soon to have been carried to Australia where it was first extensively studied and has hence come to be known as the Australian gum disease, to distinguish it from the gum disease of Java. The latter is now regarded as clearly distinct, and to be the same as the so-called leaf scald of Australia and Fiji. Java references should therefore all be referred to leaf scald and not to gum disease. Gum disease has also been found in Porto Rico and is said to occur abundantly in Colombia.

The most conspicuous symptom of this disease is a thick mucilage, or gum, which exudes from the vascular bundles when infected stalks are cut. At first this collects as colorless drops on the cut surfaces,

but it soon turns yellow on exposure and dries down as a conspicuous orange smear on the ends of the stalks. Infected canes can be easily spotted on the cars as they come in to the mill. In the field the symptoms are not unlike those of root disease. There is a general lack of thrift. Infected stools are shorter than healthy ones, and there is more or less firing or premature drying of the leaves. Many cases of top rot are usually present. Special symptoms, however, may usually be observed, consisting of rather broad, often somewhat V-shaped, discolored streaks in the younger leaves. At first these may have a water-soaked appearance or they may be simply pallid or whitish. Usually they are marked by thin reddish lines. These areas are usually near the center, along either side of the midrib, rather than on the margins. They soon dry down and may even break away. So far as known, infected stools never recover. They may soon die or they may live on for several years, always giving feeble, worthless ratoons. The decrease in tonnage is more rapid than with mosaic infection. Besides these heavy field losses, the diseased cane gives poor juices and the gum causes trouble in the defecation.

This is a typical bacterial disease. The causal organism, *Bacterium vascularum* (Cobb) Grieg-Smith occurs abundantly in the gum which fills the vascular bundles. It can be readily secured in pure cultures and quickly reproduces the disease when inoculated into young tissue near the growing point. The disease is spread in nature by means of infected cuttings and also to some extent by infected cane knives when the latter cut the tops of young suckers. It is also quite certainly transported by sucking insects, although so far there has been no experimental work to determine which species are capable of acting as carriers.

The methods of control by careful seed selection and roguing that have been recommended for mosaic will also be useful here, but the roguing will be more difficult than with mosaic since the first stages are much hardier to detect in the field. As a matter of fact, the disease has been everywhere controlled by the planting of the more resistant varieties. Thus, in Brazil, the Cavengirie was substituted for Otaheite; in Mauritius, Yellow Caledonia replaced more susceptible kinds; and, in Australia, Badila has come to be the variety most widely planted. None of those three kinds are immune to gum disease, but they are sufficiently resistant to it to make their commercial planting practicable. Matz, in Porto Rico, has tested many varieties by inoculating them with pure cultures of the causative organism. Among the better-known varieties that he finds to be very susceptible are Otaheite, Rayada, Crystalina, and B 376. Among those listed as

slightly susceptible or susceptible in the younger stages only, he finds Cavengirie, B 208, B 3405, Sealey's Seedling, and D 625. Among those found to be very resistant or nearly immune, are Uba (Kavangire), Yellow Caledonia, D 109, D 117, D 433, D 448, B 109, B 347, B 1809, B 3412, B 6292, BH 10(12), and SC 12(4). In Australia, D 813 is considered most resistant. It is indeed fortunate that we have so many good commercial canes in the resistant list.

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Leaf Scald.—This is another serious bacterial disease of sugar cane which has many points of resemblance to gum disease but which is clearly distinct from it. The country of its origin has not been determined with certainty, but it seems to have come from New Guinea. At least it has been conspicuously associated with some of the New Guinea varieties. In Java it seems at one time to have been more or less confused with sereh. Other investigators tried to identify it as the Australian gum disease. Finally Miss Wilbrink (1920) demonstrated conclusively that it was distinct from both, and North showed (1924) that the Java gum disease was identical with the Australian leaf scald.

As in gum disease, the organism of leaf scald, which by the way has not been named, is found abundantly in the vascular bundles. It is smaller and narrower than *B. vascularum* and is much more difficult to cultivate artificially, special media and technique being required. It never causes a flow of gum from the cut stalks, which is a ready means of distinguishing between the two diseases. It exists in the fields in two forms, acute and chronic. In the acute form the first symptom observable is often the sudden wilting and death of entire stools, or sometimes of only certain stalks in a stool.

This is more likely to occur in periods of dry weather. In the chronic form there is some slowing down of growth with shortening of internodes, but the characteristic symptom is the appearance of narrow, well-defined white lines on the leaves, which usually extend well down on the leaf sheaths. These lines or stripes are narrower, longer, and more clearly defined than the striping of the leaves due to gum disease. The illustrations indicate that they somewhat closely resemble the narrow form of white chimera or bud sport often seen in Cavengirie and some other cane varieties. There is, too, a prominent tendency for the lateral buds to sprout on the standing cane, a symptom that doubtless helped to confuse this disease with sereh in Java. On splitting open an infected cane, the vascular bundles are usually found to be conspicuously reddened, especially in and near the nodes. This is another typical symptom of sereh.

Infected stools never recover. They are usually short-lived, but many linger on and produce feeble, worthless ratoons. In partially infected fields the disease seems to extend rapidly in the ratoons, so that trying to make crops from them is inadvisable. Infected canes are low in sucrose and purity. Control by seed selection and roguing is very difficult since the disease, even if present, often remains dormant for considerable periods. It is spread in the field by infected seed material, by infected cane knives, and by some other agency that is often very active. This is probably some sucking insect, although this has not been proven. Inoculations with pure cultures will reproduce the disease if made in young, rapidly growing tissue, but they have no effect if made in mature tissues. The soil does not seem to become infected.

The only practicable means of control consists in the planting of resistant varieties. None have been found that are completely immune but there are a number sufficiently resistant to permit of their commercial planting. It is unfortunate that the reaction of so small a number seems to have been studied. Among those listed by North as very susceptible are Mahona (N. G. 22), 8 R 31, 7 R 96, and HD 243. Among the moderately susceptible are New Guinea 16, M 1900 Sdg., Clarks Seedling (HD 426), Pompey 17 R 428, and Goru and its sports (NG. 24, 24 A, and 24 B). As highly resistant he lists Badila (NG. 15), Malabar (Yellow Caledonia), D 1135, Innes 131, and N. G. 14. The continued popularity of Badila in Australia and Fiji is thus seen to be due at least in part to its resistance to leaf scald and gumming.

The known distribution of this disease includes Australia, Fiji, Java and the Philippines. It must be considered as a major cane

disease, and its extension to other cane-planting countries should be guarded against with every possible care. This is the more difficult since the disease is one of those that may remain dormant for long periods in what seems to be perfectly sound planting material.

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Sereh.—This disease appeared suddenly in the cane fields of Java during the early eighties of the last century. It spread rapidly and caused such serious damage as to threaten the extinction of the Java sugar industry. No cane disease has been investigated by so many plant pathologists, and none has so large a literature, but to this day it remains the least known of any of the major cane diseases. Its place of origin is unknown; its cause is absolutely unknown; it presents no certain diagnostic symptoms, since its effect on different varieties varies widely; and the symptoms usually relied on for distinguishing it may all be found in connection with other diseases. Even its geographical distribution is in dispute. It has been reported from a number of countries where we are now quite certain that it has never existed.

At the time of the first outbreak of the disease in Java, Dark Cheribon was the variety usually planted. This is very susceptible to Sereh and is very badly damaged by it. Most of the descriptions of the disease apply to its effects on this variety. Affected canes are greatly stunted in growth. The axillary buds all start into leafy shoots, but none of them make canes and the effect is that of some big bunchy grass. Sereh is the local name for lemon grass and it was applied to the disease on account of this bunch-grass appearance of the diseased stools. All the rudimentary roots also start into growth, giving the cane a hairy coating, and when diseased stalks are split open the vascular bundles are seen to be more or less reddened and often filled with a reddish resin or gum.

H. L. Lyon of the Hawaiian Sugar Experiment Station, who visited Java in 1911 for the purpose of studying this and other cane

diseases, has given us the most understandable account of sereh. He found that with other varieties, particularly with the Java Seedling 247 B (uricius), which at that time was the principal commercial variety in Java, the symptoms were quite different. With this kind there is no dwarfing of growth. Infected stalks grow to be as tall as sound ones, but there is an early and profuse development of adventitious roots and the reddening of the vascular bundles is more pronounced than in the Cheribon. This symptom seems to be the one most relied on in Java to distinguish this disease, and yet, as we have just seen, it is one of the chief symptoms of leaf scald, a disease that has often been confused with sereh in Java. These tall, well-grown, infected canes of 247 B are of small value for sugar making, being pithy and having very little juice. Even the shooting of the lateral buds fails as a diagnostic symptom. As a rule, only top seed is planted in Java. On some plantations the custom prevails of topping the standing cane to obtain planting material. This causes the upper lateral buds to start into growth, and when these shoots have made a growth of 10 or 12 inches the cane is topped again and these sprouted joints are used for planting. It has been observed, however, that with infected canes these top buds fail to start. This peculiarity is so pronounced that it is sometimes taken advantage of to secure sound seed from partially infected fields. After topping, if the side buds start freely and evenly, the stalk is considered sound and safe to use for planting.

While there is so little that can be positively stated in regard to sereh, the following points seem to be well understood. The disease is undoubtedly infectious, though just how it is conveyed from plant to plant in the field is not known. It is always reproduced by the planting of diseased seed cane. A stool once infected is always infected. In partially infected fields the disease will be much more prevalent in the ratoons. This is so marked that it early leads to the complete abandonment of attempts to secure ratoon crops. No ratoon crops have been taken in Java for many years. Sereh can be kept under commercial control by rigid care in seed selection and the abandonment of ratoon crops. It can also be controlled by the planting of resistant and immune varieties. It is confined to rather low altitudes. This makes the production of healthy seed cane much easier at high elevations in the mountains. For many years much of the seed commercially planted in Java has been grown in special seed beds in the mountains at 1000 to 2000 feet elevation.

The search for resistant and immune varieties, and later the extensive efforts to breed them, have made Java the world's center

for these lines of work. No other country has done so much for really scientific cane breeding. It was here that the first successful attempts were made to cross distinct races of cane with the idea of combining the high sucrose and good milling qualities of the noble canes with the disease resistance and vegetative vigor of the other races. There can be small question that these crosses will give us the principal commercial canes of the future.

Among the earlier importations, Red Fiji and Chunnee of North India were both found to be practically immune to sereh. They were therefore largely used in the early breeding work, usually in combination with the Dark Cheribon which was for so long the favorite among the noble canes in Java. Later it was found that Kassoer, a local kind supposed to be a natural hybrid between the wild *Saccharum spontaneum* and the Dark Cheribon, also gave immunity to sereh as a dominant character when crossed with noble canes. Crosses carrying one-fourth of Kassoer blood are among the canes now being most planted in Java.

Since sereh is an infectious disease we must suppose that it is caused by a living parasite. Notwithstanding the large number of pathologists who have worked with it, and the overly vivid imaginations of some of them, no causative agent has been certainly demonstrated. This fact, together with the general nature of the disease, suggests the possibility that it may belong in the constantly lengthening list of what, for want of a better name, are called virus diseases. Many of these produce conspicuous mottling of the leaves, as with all of the true mosaics. There are others among them that never show this symptom. Long-distance diagnoses are proverbially futile; still there can be no harm in making the suggestion that this most puzzling disease will finally be found to belong in this category.

Even the geographical distribution of this disease is uncertain. It has been reported from Borneo, Sumatra, Malacca, India, Mauritius, Australia, Fiji, Formosa, Hawaii, and the West Indies; but many of these are quite certainly cases of mistaken identity.

Recently, in Java, Miss Wilbrink showed that soaking seed pieces in hot water will largely prevent sereh. Immersing diseased seed in water at 51° C. for 20, 40, and 60 minutes reduced the percentage of sereh, respectively, to 27.3, 17.1 and 8.8. Only reviews of this important paper have been seen.

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Fiji Disease.—In 1910, attention was first called by Mr. North, pathologist of the Colonial Sugar Co., to a serious disease that had invaded the cane fields of the island of Fiji. Material was sent to Lyon in Hawaii for study, and later in the same year he visited Fiji to secure further material and study the disease in the field. Most of our knowledge of this very serious cane disease is due to his efforts.

The diagnostic feature by which it can always be recognized is the presence of elongated galls forming ridges along the veins on the lower side of the leaves. Finally the upper leaves become shortened and distorted, after which, in most varieties, the cane soon dies. No cane varieties have been found that are immune to this disease, but varieties differ widely in degree of susceptibility and in their response to the disease when attacked. In some varieties the disease always develops very quickly, while in others it may remain dormant for some months before developing recognizable symptoms. The disease is infectious and incurable, infected stools always remaining infected. Ratoons from partially infected fields always show the disease much more severely than the plant cane. This is so marked that only one ratoon crop is now taken in the island of Fiji even from the most resistant varieties.

It has nowhere been possible completely to eradicate this disease, but it is now held in commercial control by the planting of Badila and other resistant kinds, by strict attention to seed selection, and by the practice, mentioned above, of taking only one ratoon crop.

The causal organism, *Morthiella sacchari Lyon,* is a naked plasmodium of uncertain relationship, found in the gall tissues. These tissues consist of masses of pseudo-parenchyma, each cell of which, besides the nucleus and cytoplasm, contains one of the comparatively large, usually vacuolate plasmodia, occupying about half of the space in the cell. No attempt seems to have been made to determine whether this plasmodium should be considered as belonging to the slime moulds or to one of the naked-celled animal series related to Amoeba. Nothing seems to have been learned regarding its reproduction or its means of transmission in the field except as carried in infected cut-

tings. Clearly there is some other method or there would be no such rapid increase of the number of cases in ratoon fields. In young, diseased tissues the plasmodium has been observed to divide simultaneously with the division of the cell nucleus.

Badila is still claimed to be the most resistant to Fiji disease of any of the commercial canes. Childer's Zig Zag and, in the Philippines, CAC 87 are noted as being highly resistant. Among those noted as highly susceptible are Daniel Dupont, Otaheite, H 109, D 1135, Cheribon canes, Yellow Caledonia, and Uba.

This disease is named for the island of Fiji where it was first observed. It has also been found in Australia and the Philippines. In 1914 Mr. A. M. Came, an employee of the Colonial Sugar Co., made a trip to New Guinea for the purpose of collecting new cane varieties. He found this disease everywhere present in all parts of the island. It is clearly, therefore, of New Guinea origin and was doubtless carried to Australia and Fiji in some of the early variety importations from that island. This is another instance of the extreme danger of making such importations without proper safeguards. It is such cases as this which give the excuse for the excessively strict quarantine regulations now in force in many countries.

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Streak Disease.—This disease, which is characterized as "an infectious chlorosis of sugar cane, not identical with mosaic," was announced by H. H. Storey of South Africa at the Imperial Botanical Conference in London in 1924. It is perhaps not remarkable that sugar cane should be attacked by two distinct virus diseases. The potato is known to be attacked by a considerably greater number. It is, however, peculiar that Uba should be particularly susceptible to this one while it is practically immune to the ordinary sugar-cane mosaic. Storey finds the fields of Uba in Natal quite widely infected by streak disease, while the true mosaic is confined to the few scattered plantings of other varieties. The leaf pattern is different, con-

sisting of narrow, regular stripes which follow the leaf veins, and not of more or less irregular blotching as in true mosaic, and the color is lighter, often partially transparent. The symptoms, too, are confined to the leaves, there being nothing to correspond to the stem cankers of mosaic. Storey considers Uba to be rather tolerant to the disease, and yet he reports average losses of 10 per cent, which in certain cases may reach as much as 30 to 50 per cent.

Besides Uba, streak disease has been found in at least ten other varieties of cane, including both the *sinense* and noble types, in many varieties of maize, in teosinte, and in various wild grasses. It was known as a serious disease of maize for many years before it was detected in cane. As in the case of true mosaic, it is spread in the field by means of infected seed pieces and also by secondary, insect-borne infection. In this case the insect carrier is a small leaf hopper (*Balclutha* sp.) and not an Aphis. In the case of corn, the true seed does not carry the infection. Like the true mosaic, streak disease may be controlled by careful seed selection and roguing.

Among susceptible varieties are Uba, Agual, Green Natal (= Crystalina), Louzier (= Otaheite), Cavengirie, Badila, Black Innes, Egyptian 3 (= Java 147?), HQ 694, and Queensland 3. POJ 36 and POJ 213 seem to be immune.

This disease occurs widely in the Uba cane fields of Natal. It has also been reported on this variety from India and from Mauritius.

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Downy Mildew of Cane.—(Also known as leaf stripe.)—This disease was first described by Miyaki from Formosa in 1911. It is now known to occur also in Australia and the Philippines. Like so many of the more serious cane diseases, it may easily be carried from one country to another in infected cane cuttings. It may also be dis-

seminated very rapidly by light, wind-borne conidia which are produced in great numbers on still, dewy nights.

The fungus, one of the true downy mildews (*Sclerospora sacchari* Miyake),[5] causes a whitening of the infected portions of the leaves due to the great numbers of conidiophores formed. The invaded tissue usually soon dies, causing a conspicuous striping of the leaves. Infected plants are much stunted and dwarfed, but there is a tendency for the internodes to become long and slender. The fungus also attacks corn and sorghum.

While not as destructive as Fiji disease, downy mildew is considered a major cane disease of great importance. It is harder to control than most cane diseases on account of the wind-borne conidia and because the soil becomes infected by the oospores.

Uba is particularly susceptible, while Cebu Purple seems to be somewhat resistant, and H 109 is comparatively resistant. B 147, D 1135, HQ 426, and M 1 are reported as being badly attacked in Australia.

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Sugar-cane Smut.—This disease is caused by a parasitic fungus, *Ustilago sacchari*. The mycelium invades the entire plant, usually causing a marked stunting of growth but giving no other outward sign until the cane arrows. The arrow is converted into a black, whiplash-like organ mostly composed of masses of the minute black spores. These are wind-borne and serve to spread the disease widely. It may also be carried from place to place in infected cuttings.

No efficient control measure seems to have been worked out. Sugar-

[5] Another species, *Sclerospora spontanea* also attacks sugar cane in Formosa. This is an indigenous species on wild cane in all parts of that island. *S. sacchari* was imported from Queensland in 1917.

cane smut is primarily a disease of the wild cane, *Saccharum spontaneum*. It is also very severe on Uba and others of the *Saccharum sinense* group. The noble canes are less liable to injury. Badila, D 1135, H 109, and Yellow Caledonia are considered to be immune, but Luzon White and Pampanga Red are affected.

Smut has been reported from India, Java, Formosa, the Philippines, Natal, Mauritius, Queensland, Italy, and British Guiana.

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Sugar-cane Rust.—This name has been rather loosely applied in the literature to any spotting of the leaves. The term should be confined to the orange-colored pulverulent spots and lines caused by the Uredo sori of the true rust, *Puccinia Kuhnii* (Kruger) Butler. The mature or *Puccinia* stage was found on the wild cane, *Saccharum spontaneum*, in Burma, by Butler. It is usually only the Uredo stage that is seen on cultivated cane.

This disease is abundant on cane leaves in the moister districts of Java and the Philippines. It is considered to be of only minor importance.

Louisiana Ribbon, Rose Bamboo (Crystalina) and Dark Cheribon are mentioned as often attacked in the Philippines. No remedial measures have been reported. Doubtless there is a considerable difference in varietal susceptibility.

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Eye Spot.—This name has come to be applied to a sugar-cane leaf disease caused by the fungus *Helminthosporium sacchari* (Breda

de Haan) Butler, which is attracting considerable attention in various sugar-cane-growing countries, some of the varieties that have recently become popular proving to be particularly susceptible to it. In Hawaii the famous H 109 is susceptible, especially in seasons with much rainfall, and in Porto Rico there has been trouble with D 109, BH 10(12), and especially with the Fajardo varieties, FC 214 and FC 306. These latter are also showing the disease seriously in Cuba and will probably have to be abandoned on account of it.

Unlike most of the fungi causing spots on cane leaves, this species shows considerable parasitic ability, usually causing the worst damage on the younger leaves. It is said in Hawaii that four or five infections per leaf usually cause but little damage, but when they are numerous, up to thirty or more, the spots coalesce, often killing the leaf and sometimes causing a top rot.

Experiments with airplane dusting with sulphur have given fair control in Hawaii, but copper fungicides have not been so effective. Practical control, however, will usually consist in the planting of resistant varieties. It is unfortunate that some of the best commercial kinds, including H 109 and BH 10(12), should be susceptible. Our knowledge of the behavior of most other varieties is not sufficient to list them accurately as to susceptibility, but the following are known to be quite resistant: Badila, Crystalina, Uba, Yellow Caledonia, Yellow Tip, D 117, D 1135, and many of the POJ kinds.

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Brown Spot.[6]—A somewhat similar leaf spot, caused by a related fungus, *Cercospora longipes* Butler, is reported as causing consider-

[6] A leaf spot has recently been described from Cuba, by J. A. Faris. (Facts About Sug., Nov. 3, 1927, p. 1185), under the name of brown stripe. This seems to have been previously confused either with brown spot or with eye spot. It is caused by a species of *Helminthosporium* which is quite distinct from *H. sacchari;* its appearance on the leaf is somewhat different and it attacks a different set of varieties. Crystalina is commonly and heavily infected with brown stripe although it is practically immune to eye spot.

able damage in India. It occurs also in Cuba and Porto Rico but so far is of minor importance. The spots are more regular in form than in eye spot and are less likely to coalesce. Otaheite was reported as attacked in Porto Rico. But little is known as to variety susceptibility.

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Ring Spot.—This is the name usually given to a very common spotting often observed on the older, mature cane leaves. The spots are pallid, irregularly rounded, usually 5–10 mm. in diameter, and with a rather conspicuous, reddish brown border. The spots usually show minute black specks which are the fruiting bodies of the fungus *Leptosphaeria sacchari* Breda de Haan.

This spotting is usually of but little importance since it only occurs on the older leaves which have largely passed their period of usefulness. The fungus seems to have but little parasitic power, the spots usually originating as minute insect punctures.

Varieties differ considerably in the amount of spotting which they show. In some countries this spotting is known as "rust," but it has nothing to do with the true cane rust which has already been discussed. It probably occurs in all cane-growing countries but usually is of only minor importance.

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Red Stripe.—This is a comparatively new bacterial disease of cane leaves. It seems to have been first observed in Australia, but it is also present in Hawaii where, so far, it has proved to be serious only on the Tip canes. It has recently been reported in Louisiana. The first indication of this disease is a dark, watery, green streak, 2–4 cm. long by about 2 mm. wide, at the base of the younger leaves.

This soon turns brown and then blood-red. These streaks may be abundant enough to coalesce, causing all of the younger leaves to be brilliantly colored. Such severe cases usually end in a top rot. The disease may be induced by inoculation with infected cane juices or with pure cultures of the bacterial organism. Clearly, this is a disease with possibilities for great damage in susceptible varieties, since it would seem to be ideally adapted for rapid spread by sucking insects. It deserves most careful study, and every precaution should be taken to prevent its being carried to other cane-growing countries.

Some confusion exists in the literature since the same name has also been applied to red streaks in the midribs caused by the red rot fungus, *Colletotrichum falcatum*. This, however, is a trouble of only minor importance.

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Red Spot of Leaf Sheath.—Conspicuous, rather large, irregular areas of a dark-red color are often seen on old leaf sheaths. Close inspection will show them to be scattered with minute black specks which are tufts of the spore-bearing hyphae of the fungus *Cercospora vaginae* Kruger. Although everywhere present, especially in fields of Crystalina cane, this disease is apparently of only minor importance; still, it doubtless somewhat hastens the drying of the older leaves. Varieties differ considerably in susceptibility, Crystalina, as noted above, almost always showing it conspicuously while Yellow Caledonia and Cavengirie are seldom affected.

It has been noted in many parts of the sugar-cane world.

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Red Rot of Leaf Sheath.—The fungus *Sclerotium Rolfsii Sacc.*, well known in the southern United States as the cause of a serious wilt of many garden vegetables, is abundant in tropical cane fields

in many parts of the world. It grows as a saprophyte on the old cane trash, but often, especially in damp weather after the cane closes in, it invades the still-living tissues of the leaf sheaths, causing them to turn an effused orange-red and killing them prematurely. Overly shaded young suckers are often completely enveloped and killed by the rapidly growing, conspicuous, white mycelium. These injuries are usually of small importance, or at least they have attracted but scant attention. Frequently, however, especially in heavy cane in moist situations, the fungus penetrates the leaf sheath and attacks the cortex of the cane itself, killing surface areas which develop as deep cankers or pits which may coalesce in lines and thus form deep cracks. Such canes are much weakened and are exposed to further losses from various decay organisms. Fields have been observed where the total loss from these cankered canes must have been very considerable. These lesions have some superficial resemblance to the cankers caused by mosaic, although it is usually easy to distinguish between them. Some of the supposed cures of mosaic have been based on the planting of seed pieces showing *Sclerotium* cankers that had been mistaken for mosaic cankers. Naturally, such of these seeds as grew came up free from mosaic.

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Banded Sheath Spot.—Besides the species of Rhizoctonia that are connected with the killing of the roots in root disease, there is one, *R. grisea* (Steph) Matz, which occurs on the leaf sheaths and sometimes on the bases of the older leaves. This causes large, irregular, usually zonate-banded, deadened areas. The rather large, grayish sclerotia are usually produced sparingly. They are flat or sometimes concave, 2–5 mm. in diameter and slightly attached to the leaf or sheath surfaces by very fine, hardly visible strands.

This seems to be a disease of minor importance although occasionally certain stools are seriously injured by it. There are indications of considerable differences in varietal resistance but this has not been sufficiently studied.

It occurs in Porto Rico and Cuba, and what seems to be the same thing has been reported from India, Java, and the Philippines.

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Cytospora Sheath Disease.—This is usually a disease of minor importance, but at one time it was causing considerable damage in Porto Rico on certain susceptible varieties. It is caused by the fungus *Cytospora sacchari* Butler. The leaf sheaths are turned a dark, dull red, and they are firmly bound and matted together by the mycelium, and by the numerous black needle-like necks of the fruiting bodies which conspicuously roughen the surface. The leaf blades usually bend over at the junction and hang parallel to the stalk, giving a characteristic appearance. Growth is checked, and sometimes young stalks are killed. On nearly mature canes, typical cankers or lesions are produced.

Clearly, this is a disease with really serious possibilities. Luckily, so far it has been confined to a few varieties and to wet seasons and moist localities.

Varieties affected in Porto Rico include Rayada, B 1355, B 1753, B 3696, B 3922, B 4596, D 109, and D 117. It was, however, only B 3696, B 3922, and B 4596 that were seriously affected.

This disease has so far been reported only from India, Brazil, and Porto Rico.

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Iliau Disease.—Another fungus, *Gnomonia iliau* Lyon, has caused very similar damage to the last mentioned in Hawaii and Louisiana. It seems to have been of only minor importance, or at least it has attracted but little attention in recent publications.

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Red Rot.—This is the name usually applied to the rotting of cane stalks caused by the fungus *Colletotrichum falcatum* Went. The name refers to the reddening of the internal tissues. In the earlier stages at least, there is no striking change in the external appearance of affected stalks, and since the fruit bodies of the fungus are comparatively inconspicuous it is often difficult to distinguish this trouble with certainty. As a reddening of the tissues occurs when they are invaded by any fungus or bacterial organism, this symptom is of slight diagnostic value; but with this disease the reddened tissues show peculiar, elongated, whitened spots when the cane is split open.

This trouble has been reported as occurring in many parts of the world, but, apparently, it is only in subtropical countries where cane is sometimes subjected to freezing temperature that serious damage occurs. In both northern India and Louisiana it is considered one of the serious cane diseases. It causes rapid inversion of sucrose, the amount of loss depending on the stage of infection. In Louisiana it is estimated that stalks infected with red rot average 25 per cent less sucrose than corresponding healthy ones. Much of the loss of sucrose always found in borer-infested canes or infested joints is there attributed to this fungus rather than to direct borer injuries. Red rot has been reported from many tropical countries but has nowhere been considered as serious under tropical conditions. This, however, may be partly due to lack of sufficient study. Canes attacked by this fungus are also soon invaded by the rind fungus, *Melanconium*, with its conspicuous black pustules which completely mask the *Colletotrichum*. We really do not know what part of the damage is really caused by red rot.

In the Philippines, *Colletotrichum* is said to occur only as a leaf fungus, causing long red discolorations of the midribs. This red discoloration of the midrib, often extending for a distance of several centimeters, is also common in Cuba and Porto Rico but it seems to be of minor importance. The disease is sometimes referred to as "red stripe," which is likely to confuse it with the bacterial red stripe, a much more serious trouble which has already been mentioned.

In Louisiana it is found that the red rot fungus gains entrance to the stalks through borer holes and other injuries, but that it may also enter through the rudimentary root tips in the root band at the nodes. It is particularly troublesome in windrowed cane that is being carried over for spring planting, being a very common cause of poor

germination. This disease is found to be more prevalent in wet than in dry seasons.

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Rind Disease.—At one time this had a conspicuous place in cane literature, especially in that concerning the British West Indies. The fungus, *Melanconium sacchari* Mass, is a common saprophyte on dead cane tissue, probably occurring in every cane field in all parts of the world. Its conspicuous, conical fruiting pustules which break up through the epidermis always attract attention. It is, however, perhaps doubtful if any specific disease is caused by it. It is a constant accompaniment of borer and other mechanical injuries. As we have just seen, it usually closely follows attacks of red rot, and it is always present as the final stage of serious cases of root disease. It seems probable that the greater part of the cases referred to in the literature as "rind disease" might better have been called "root disease." This is particularly true of those records connected with the running out of the Bourbon or Otaheite cane in the West Indies.

This fungus, however, and the injuries it causes deserve much more critical study. Under what circumstances it may become a dangerous facultative parasite we do not know. There is some evidence that it causes a reddening and plugging of the vascular bundles, somewhat as in Matz's vascular disease, and that it may also be the cause of a basal stalk rot that affects mature canes of some varieties.

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Pineapple Disease.—The fungus *Thielaviopsis paradoxa* (De Seynes) J. Hohn, which is a serious pineapple disease, causing much loss from the rotting of the fruit, also causes the rotting of seed-cane cuttings. When conditions for germination are unfavorable the loss of seed is sometimes considerable. This disease has never been reported as damaging standing cane. *Melanconium* and *Colletotrichum* also cause the rotting of seed pieces, but the present trouble may be detected by the blackening of the internal tissues and by a peculiar fruit-like odor.[7]

While it occurs in many parts of the world, serious damage to cane has only been reported from Java and the West Indies.

Dipping the seed pieces in Bordeaux mixture proves to be an effective preventive of this trouble. At one time it was extensively practiced in Porto Rico, but when planting under favorable conditions for germination the expense of this precaution is seldom justified, and it is less practiced than formerly.

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Red Vascular Disease.—We have already seen a reddening of the vascular bundles to be one of the principal symptoms in sereh, leaf scald, and Matz's vascular disease. A trouble said to be distinct from any of these has been observed in the Philippines and probably also in Hawaii. It causes the reddening of the bundles and the wilting of the leaves.

H 109, Louisiana Striped, and Negros Purple are among the varieties infected.

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Sugar Cane Wilt.—This disease, first described from India, is of considerable importance in that country. The fungus causing it, *Cephalosporium sacchari* Butler, seems to be an active parasite causing

[7] The rotting of seed pieces with a similar black color and odor is also caused in India and Louisiana by the fungus *Ceratostomella adiposum* (Butl.) Sartoris. This was first described by Butler from India as *Sphaeronema adiposum*. See Butler, E. J., Fungus Diseases of Sugar Cane in Bengal. India Dept. Agr. Mem. Bot. Series 3, 1906. Sartoris, G. B.—Jour. of Agr. Research 35, No. 7, 1927.

the rotting of the affected stalks and the wilting of the leaves. It may be distinguished from red rot by the color of the diseased tissues, which are a dirty purple with red spots, instead of being red with white spots. Canes and stools attacked by wilt are soon killed.

It has also been reported from the Philippines, Natal, and the West Indies.

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Top Rot.—We have seen that a dying of the top is a frequent symptom in root disease, Matz's gum disease, gummosis, and various other troubles. It is also often caused by borer injuries, both in old, mature cane and as "dead hearts" in young canes. This dying of the top may be followed by a stinking bacterial rot, or the top may simply dry down, often showing the fruiting bodies of various secondary saprophytic fungi. The opinion seems to prevail widely, however, that there is a special top-rot disease. At least, such cases are frequently reported in recent pathological literature but nowhere with full diagnostic descriptions. Both Cross and Fawcett mention top rot in Argentina, and Cottrell-Dormer and Tryon speak of it as doing appreciable damage in Queensland.

A "top wilt," seemingly confined to the EK 28 variety, is recorded in Java by Miss Wilbrink. She found no organisms in the wilting tissues and failed to transfer the trouble by inoculations. Her discussion strongly indicated that the cause of the trouble should be looked for at the roots or the base of the stalk.

Pokkah bong, or twisted top, a trouble first reported from Java but recently found rather commonly in Louisiana (La. Bull. 197 : 34, 1926), sometimes results in the dying of the top. This has been supposed to be a malformation, but the Louisiana discussion indicates that it may be similar to a condition frequently observed in Cuba and Porto Rico, when some parts of the young leaves in the terminal bud spindle seem to show a bacterial infection which distorts and partially destroys them.

Clearly, the whole subject is greatly in need of further critical study.

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Node Galls.—Occasional galls, often developing into adventitious buds, have been observed for many years, both in Hawaii and in Java. They have been considered as accidental abnormalities. Recently (since 1924) they have occurred so frequently and persistently in certain trial grounds in Hawaii as to cause renewed interest and the suspicion that they may represent an infection. They occur most conspicuously on certain Uba (Zwinga?) XD 1135 hybrids, but many seedlings of noble canes are also affected. The trouble has been observed on a total of seventy-four varieties, forty-four of which have Uba blood. These canes all occurred at the Makiki Experimental plots near Honolulu, but occasional galls are frequently found on H 109 and other varieties in other parts of the islands.

These galls may develop on any part of the stalk, but they are most frequent on the root band and "stem node" (growth ring). They are first discernible under a hand lens as minute, watery blisters, either single or in coalescing groups on the very young tissue protected by the overlapping leaf sheaths in the terminal bud spindle. They grow into very irregular and diverse shapes due to the pressure of the leaf sheaths. Galls often develop more or less clearly marked folioid structure, and occasionally they develop adventitious buds which may grow into normal leafy shoots. Where the terminal bud itself develops gall tissue, a peculiar, branched, bushy structure results. This has previously been noted and described as "bunch-top." It may consist of a cluster of strap-shaped folioids, or of regularly formed leafy stems.

The cause of these galls is still unknown. No organism has been detected in connection with them. Cuttings showing adventitious buds on gall tissues have been planted and have developed apparently healthy stools. Inoculation experiments have given no results; and yet, from the behavior of the galls in the field, the fear remains that the cause may be some undetected infection that is being spread by insects or other unknown means.

When Lyon visited Java in 1911 he was shown specimens preserved in the museum of the East Java Experiment Station that clearly represented these same galls, and his attention was called to an article by Kamerling, published in 1900, on "Adventitious Buds on Sugar Cane," the illustrations in which clearly represented gall formations.

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Bunga.—In the Philippines, a flowering-plant parasite of sugar-cane roots, *Aeginetia indica,* is reported to be increasing and causing really serious damage, some fields being found with as much as 90 per cent of infection. The parasite produces showy flowers, said to resemble a tulip. The attacked plants show a very serious falling off in available sucrose.

Where the infestation is light, it is recommended to dig up and burn all diseased stools to prevent the flowering of the parasite. Heavily infested fields should be plowed up and destroyed.

A closely related species is reported from Java where it seems to be restricted to high altitudes. It is not expected to be serious.

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Lime Chlorosis.—Areas in certain fields are sometimes observed where the young cane, either plant cane or ratoon, has all turned to a conspicuous uniform yellow. This is usually attributed to an excess of lime in the soil. It certainly often occurs on shallow soils with a calcareous subsoil; but as it also occurs on deep alluvial soil, and on the Cuban "red land," which is always low in available lime, it is by no means sure that the name is well chosen or the cause understood. More often it is confined to certain well-marked areas where all the cane is affected. At other times occasional plants may be seen scattered about in fields that are mostly normal. The color varies considerably; usually it is a clear, bright yellow, but badly attacked plants become almost whitish. Such plants sometimes die. Usually, however, after a few weeks the field recovers and seems to make practically a normal growth.

This trouble has been observed in Porto Rico, Cuba, the British West Indies, and Hawaii.

As was first pointed out in Porto Rico, spraying the leaves of chlorotic plants with a solution of iron sulphate restores the green color. This has been confirmed in Hawaii, where it is reported that

two plantations have adopted commercial dusting with powdered iron sulphate.

Varieties show considerable difference in resistance to chlorosis. Badila and Crystalina are quite susceptible. In Porto Rico, B 3412 and B 1753 were reported to be resistant. In Cuba, the POJ series all show good resistance.

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Pahala Blight, or Striped Chlorosis.—Another form of chlorosis appears as light yellowish or pallid uniform stripes, about 5 mm. wide and running the entire length of the leaves. This seems to appear on soils with a strong alkaline reaction, but apparently it is caused by sodium salts rather than by lime.

It has been considerably commented on in Hawaii, and what seems to be the same thing occurs not infrequently on the South Coast of Porto Rico. Growth is retarded, and cane is sometimes killed. There is considerable difference in varietal resistance, D 1135 being resistant and Yellow Caledonia quite susceptible.

McGeorge in Hawaii finds that it is due to lack of available iron in the soil and that it may be cured by applications of sulphur, which increases soil acidity and renders iron more soluble. Dusting the leaves with manganous sulphate also causes the stripping to disappear. It is claimed that one plantation in Hawaii is using sulphur on a large area to cure this trouble.

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See also Facts About Sug., Apr. 9, 1927, p. 295.

Cold Chlorosis, or Sectional Chlorosis.—In Cuba it is not uncommon, during the winter, to see young plants of certain cane varieties with the leaves marked by peculiar whitened cross bands. These markings are so conspicuous as immediately to attract attention. Under field conditions they have been observed commonly only in Cavengirie cane, Crystalina seldom or never showing such markings. In variety plots, H 109 and D 1135 were found to be particularly sensitive, while a number of other kinds showed the markings in a

less degree. The fact that these markings appeared after some unusually cold nights finally gave Dr. Faris the key, and he was able to demonstrate that the markings were caused by cold water which collected, either from rain or dew, in the unrolled bud spindle. A temperature of from 5° to 10° C. would produce the markings in susceptible kinds. Dr. Faris was able to induce them artificially by using ice water in the bud spindles.

Similar markings were reported from Hawaii, Australia, and Louisiana, at the meeting of the International Association of Technologists in Honolulu.

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CHAPTER VI

INSECT AND OTHER PESTS OF SUGAR CANE

The number of insects and other low animal forms that feed on sugar cane is very great, and the combined damage which they cause is fairly appalling. Seriously injurious kinds are found in all sugar-cane-growing countries. These more important ones have received considerable study, but there are many others, usually doing only minor injuries, which have been scarcely more than noted, and whose life histories are still in many cases unknown.

Obviously, in a general work of this kind it will be impossible even to list all of them. The best that can be attempted is to call attention to the more serious ones and to cite such of the literature as will enable the reader to follow farther any line in which he may be especially interested.

As is the case with cane diseases, there are none of the principal cane pests that are held in check by special remedies or topical applications. It is true that attempts have recently been made to control the moth borer by airplane dusting. So far, however, this can only be considered as being in the experimental stage. Of course, young cane fields could be dusted or sprayed with any of the usual machinery for such work. Their great size, however, would make the work expensive. For full-grown cane no method of making such applications is available except by the use of airplanes. They are already being employed extensively in dusting for the cotton boll weevil. The time when the moth borer can be reached by dusting would seem to be the few days after hatching when it is still feeding on the leaf surfaces. This may or may not prevent the full success of this method of control. It seems unquestionable, however, that army worms and other similar leaf-feeding, chewing insects could be completely controlled in this way at any time that their number justified the expense.

Various attempts have been made to control insect pests by changes in cultivation methods, by the planting of trap crops, and even, in many cases, by the laborious hand picking of injurious species. It cannot be said that any of these measures has been fully satisfactory.

In most cases, insects continue to take their usual toll in the cane fields.

The only really spectacular successes that have been achieved in insect control have come from the importation of insect parasites which have attacked the troublesome species and so reduced their numbers that their injury become negligible. Such a case was the control of the sugar-cane leaf hopper in Hawaii, where at one time it seriously threatened the industry. Unfortunately, this attractive remedy is not universally applicable. We find in nature a complicated series of checks and balances which keep the native flora and fauna in equilibrium. Each flowering plant is fed upon by certain special insects. Each of these in turn is held in check by one or more special parasites. If the parasite multiplies unduly and stings too many of the plant-eating insects, it soon finds a shortage in its food supply. If, however, it fails to infest the usual proportion of its hosts, they increase unduly and eat up too many of their food plants until they in turn are checked by food shortage and thus the balance is maintained with a slight swing first in one direction and then in the other. Any plant or animal that fails to adjust itself to this equilibrium is soon exterminated and goes to join the long array of extinct forms. Now, when man steps in and plants great areas of some one plant, calls all of its natural competitors weeds, and proceeds to exterminate them by cultivation, he upsets this delicate balance. The insects feeding on this special crop plant naturally increase enormously with such a bountiful food supply, and soon they are numerous enough to do very serious damage to the crop. If both crop plant and insect are indigenous, the native parasites will in turn quickly increase until a rough equilibrium or balance is again attained, except in those cases where some feature of the cultivation proves unfavorable to them. This has happened with the parasites of the moth borer in those regions where the annual burning of the fields is practiced. Even when a rough balance is reached, the normal oscillation, or swing, first in favor of the parasite, then of the insect, and then of the crop, will be so intensified by the enormous numbers involved that the amount of insect injury will vary considerably in different years.

In many cases, however, the crop plant is an imported one. This has been the case with sugar cane in a great majority of the countries where it is now cultivated. If by chance the imported plant is free from any of its native insect pests, it is likely at first to thrive finely but, sooner or later, insects will adapt themselves to feeding on it. Being natives, they will be accompanied by their usual parasites and

an equilibrium will be reached which may or may not include considerable crop losses. It has often happened, however, that in introducing a new crop plant one or more of its usual insect pests have inadvertently been imported at the same time. If by chance they have come in without bringing their usual parasites with them, the case at once becomes serious. With an abundant food supply they multiply unchecked until the damage caused is really alarming. This is just what happened in Hawaii with the cane leaf hopper, which seems to have been brought in from Australia with an importation of cane varieties. Within a few years it had so multiplied as seriously to threaten the Hawaiian sugar industry. Luckily, the entomologists of the Sugar Planters Experiment Station succeeded in finding the native parasites of the leaf hopper in Australia, and in importing them successfully. Within a few years they had restored the balance and had reduced the leaf-hopper menace to negligible proportions.

It is only in the case of such introduced insects as have come without their usual parasites that we can hope for such sweeping results. True, when native parasites are failing for any reason to hold a given pest in check satisfactorily, additional ones can sometimes be imported that will be more effective. Then, too, a careful study of life histories may show where cultural methods may be so altered as to give better control results. While all entomologists recognize the limitations of this method it is small wonder that they are so immensely interested in the subject of parasites and their introduction.

Since this is a treatise on sugar cane and not on entomology, these pests will be taken up and considered in relation to the injuries caused, and the parts of the cane attacked, rather than in the sequence of their systematic relationships.

As a matter of convenience we shall consider first those insects causing damage to the cane stalks. Of these, the stalk borers are by far the most important. There is also a group of sucking insects, like the mealy bugs, which live on the stalks, and a few kinds that do most of their damage by cutting off the young stalks at or below the surface of the ground.

The most troublesome and destructive of all sugar-cane pests are to be found among the stalk borers. These are of many kinds in different parts of the world, and they belong to two widely differing groups of insects, the moths and the beetles. The damage done is quite similar in all cases, however. The larvae bore tunnels in the soft tissues of the stalks. These injuries may so weaken the stalks

that they are broken off by winds, or, in many cases, may cause the death of the top above the injury. In all cases, they give entrance to the fungi causing red rot and rind disease, and to other ferment organisms which invert the sucrose, causing lower purities in the juices and a marked lowering of sugar yields. These secondary effects are much more serious than the direct physical effects of the borer tunnels.

The West Indian moth stalk borer.—(*Diatræa saccharalis* Fabr.) This is one of the most widely occurring and destructive species. It is abundant in all parts of tropical and subtropical America, feeding and breeding freely on cane, but also attacking corn, sorghum, and some of the larger grasses. It is not dependent on any of these other food plants, however, but can exist generation after generation in the cane fields.

The adult is a sluggish, gray, night-flying moth about an inch long, which shelters during the day in the cane fields. It is not a strong flier and usually deposits its eggs in the immediate neighborhood from which it has emerged. It is short-lived, usually living only about four days. The eggs, which are flattened and circular in outline, are laid in overlapping clusters of a dozen or more on the midribs of the younger leaves. These eggs hatch in about a week, and the minute larvae feed on the surface, gradually working down between the superimposed leaf sheaths until they can make their way within. It is during this brief period of exposure that they can be attacked by poison dusts. The moths prefer to oviposit on young, rapidly growing plants. If corn is planted near the cane fields as a trap crop, the moths will to some extent go to that in preference to the cane, and by cutting and feeding it before the borers emerge this portion of them will be destroyed. If the corn is allowed to ripen, however, the borers will leave it as they emerge and go back to the cane. After the young larvae enter the stalk it is less than a month until they are ready to emerge and begin the cycle over again. Under tropical conditions at least, there is thus a continued succession of overlapping broods. The longer the cane stands in the field, the greater the proportion of stalks that become infested. Of course, the mill rollers effectively put an end to all borers in the stalks which reach them, but enough escape in stalks scattered in the fields, or at the loading stations and along the railways, to keep up a full supply. It is usually noted that borers are much more abundant in places where lost stalks are most likely to occur. High-cut stubble is another important source of carry-over.

It is usual to caution against the planting of borer-infested seed.

Rules are even given for disinfecting it. Immersion of the seed pieces for twenty minutes in water at 50° C. is said to kill all borers and mealy bugs and to hasten germination. If buds have germinated they may be injured by the hot water, but soaking in cold water for seventy-two hours will kill the pests equally well with no injury to sprouted buds. The planting of infested seed is certainly not to be recommended, since such seed is much more likely to rot in the ground and fail to germinate; but since, as usually planted, the covering of an inch of dirt will prevent the moths from emerging, the expense of special seed treatment is hardly justified.

Since this borer is indigenous in the West Indian region, it would be natural to expect that here, at least, it would be effectively controlled by native parasites. There are known to be a very considerable number of *Diatræa* parasites in these regions. A certain equilibrium does seem to exist. At least, borer injuries are less serious in Cuba and Porto Rico than in Louisiana and Western Mexico. The balance, however, is far from being a satisfactory one. Recent studies in Cuba indicate that the average infestation is much higher than had been supposed and, further, that the distribution of the borer is very irregular even within limited areas. According to Van Dine, at eleven centrals studied, scattered through three provinces, the borer infestation ranged from an average of as low as 8 per cent, to as high as 32 per cent, the average for the entire eleven being 19 per cent. Chemical studies indicated that in these infested stalks the sucrose content was reduced by 12.27 per cent of that found in normal juices, or an average reduction of 2.33 per cent in total sucrose. These figures give some idea of the enormous losses being caused by this insect, even in a country where parasite control had been considered satisfactory. What can be done to reduce this total, and especially to reduce the losses where infestation is now highest, are among the serious problems confronting the Cuban sugar industry. In Louisiana, losses were estimated at 17 per cent of the crop in 1922, and at 23 per cent in 1923. Here, owing to the effect of climatic conditions, the losses seem to vary from year to year more widely than they do in the tropics. Western Mexico and Peru also report very heavy borer losses.

Naturally, the question of parasite control has received much attention. Many attempts have been made to introduce Cuban parasites in Louisiana and in Mexico, but so far the results have not been fully satisfactory.

Of the Cuban parasites the most important are the tachinid fly, often called the Cuban fly, *Euzenillopsis diatrææ* Townsend, which

parasitizes the larvae; and the minute chalcid wasp, *Trichogramma minutum* Riley, which is an egg parasite. Probably of less importance in Cuba are the fly, *Sarcophaga sternodontis* Townsend, which has been bred from the pupa; *Apanteles diatraæ* Muesebeck, a braconid hymenopter which is parasitic on larvae; and *Bassus stigmaterus* Cresson, an *ichneumon* wasp, also on larvae. In addition larvae and pupae are sometimes infected by the fungus parasite *Cordiceps barberi* Giard, but this is usually of no great importance. From other countries have been reported *Ufens niger* Ashmead, another egg parasite from the southern United States; *Paratheresia signifera* Townsend from Peru; and species of *Microdus* and *Ipobracon* from Venezuela. *Ipobracon grenadensis* has recently been successfully imported from that country to south Porto Rico. Brethes, too, has just described (1927) four new *Diatraa parasites* from Argentina. These are *Microdus crossi* n. sp., *Ipobracon tucumanus, Aulatopria tucumana* n. gen. *et* n. sp., and *Sarcophaga diatraæ,* n. sp.

The more practical problems remaining in this connection would seem to be, first, the more general and systematic introduction of any of these parasites into countries or districts where they are not now found; and, second and probably most important, the careful study of conditions which are now preventing parasites already present from giving satisfactory control. With the complete disarrangement of natural conditions and the enormous increase in number of borer food plants, caused when great areas are kept continuously in cane, this much desired natural control may prove difficult or even impossible.

Another question to be considered is that of varietal resistance to borer infestation. We have seen how important the question of variety is in the control of many sugar-cane diseases. It is not likely to be equally important here, for the borer, if pushed to it, will probably breed in any of them just as it does in corn and other big grasses. Still, there can be no doubt that, other things being equal, some varieties will be infested more than others. Wolcott, in Porto Rico, has made extensive notes on the percentage of infection in different varieties, but he could reach no positive conclusions on account of the numerous other factors involved. Cross, in Argentina, states emphatically that the slender POJ canes are less injured than the thick noble canes and that, with the general planting of the former the borer has ceased to be a problem although formerly very serious. On the other hand, in Louisiana, the fear has been expressed that these same POJ canes were going to prove unduly susceptible to borer attack. Uba and its relatives, which are so resistant to many

diseases, seem to be even more susceptible to borer than the average of the noble canes.

Notwithstanding the great amount of work done on this pest in different parts of the world, and the voluminous existing literature, it must be confessed that no satisfactory control has yet been worked out for the moth stalk borer. Doubtless, parasites are helping very materially. Without their aid, losses would be very much greater, but this natural method is nowhere proving fully satisfactory. Possible means of improving it are being studied by many of our ablest entomologists.

Airplane dusting holds out some promise of relief. Under tropical conditions at least, where moths may be emerging and laying eggs at almost any time, the prospect for complete success seems doubtful.[1]

Cutting out "dead hearts" in young plant and ratoon fields will probably be worth its cost in reducing subsequent infestation in these same fields. This, however, could never be considered as a control, but, like most of the following methods, as a means of alleviation.

Where possible, borer-free seed should always be selected for planting, on account of its much better germination. If, however, a few infested seeds are planted, no great harm will result, since the adults cannot emerge if covered with as much as an inch of earth. Soaking seed cane in either hot or cold water may be desirable to secure better germination or for other reasons, but it is seldom justifiable solely as an aid in borer control. The planting of non-infested seed is an important factor in those regions where only one or two crops are taken, but it can have little effect on the final outcome in fields that are to be ratooned for successive years.

It is sound advice to harvest heavily infested fields first, and, as far as possible, to avoid carrying over mature cane from one crop to the next. In plantation practice neither of these is always practicable, but they are valuable points to keep in mind.

Clean harvesting, low cutting, and care to prevent the scattering of infested canes between the field and the mill are always needed. Good management will show itself in such details quite as clearly as in larger matters.

Losses through inversion of sucrose between cutting and grinding will undoubtedly be greater and begin earlier in infested than in sound cane. On only too many plantations this is one of the most serious sources of avoidable losses. The bigger the mill the greater the likelihood of such trouble.

[1] Since the above was written, extensive airplane dusting in Louisiana has given practically negative results.

Finally, in the interest of borer control, there can be no question that the burning of the fields, either before or after cutting, should be avoided whenever possible. Burning the trash in the fields used to be advised as a means of borer control, but it seems to be well established that this practice destroys the borer parasites much more effectively than the borers. Frequent cane-field fires are probably one of the reasons why borer control through parasites has never been more fully effective.

Other Sugar-cane Moth Borers.—Besides the common West Indian species already described, there are a considerable number of other moth borers in various parts of the world, some of which are fully as destructive. Three or four other species of *Diatræa* also attack cane in different regions.

The larger corn stalk borer, *Diatræa lineolata* Walker, is also found on cane. It occurs in the southern United States, Cuba, several of the other of the West Indies, and in Central and South America.

Diatræa canella Hampson is found in Trinidad and Guiana, and *D. incohati* has been reported from Guiana.

Diatræa striatalis Sn., the gray borer, is a serious pest in Australia and Java.

Castnia licus (Ballon) Druvy, the larger moth borer, is found in Trinidad and the Guianas.

Chilo simplex Butler is an important species in India and Formosa, attacking cane, corn, sorghum, rice, etc. Another species, *C. auricilia,* is known as the gold-fringed borer of India, and *C. loftini* Dyar occurs in Mexico. *C. infuscatellus* is the yellow borer of Java.

Laspeyresta schistaceana Sn., the gray borer, is a serious pest in Java.

Phragmatiphila truncata Walk., the moth borer of Australia, is said to be parasitized by a minute braconid wasp which ordinarily prevents it from doing serious damage.

Sesamia cretica Led., the durra stem borer of the Soudan, is also a serious pest in cane and corn, while *S. monagrioides* is the purple borer of Java, Mauritius, Northern Africa, and Spain.

This list is by no means complete, but it will serve to show what an important group these moth borers are and how widely they occur in all parts of the world.

Rhabdocnemis obscurus Boisduval, the Pacific weevil borer, is a very serious pest in Hawaii, Australia, and many of the other Pacific countries. It has also been reported from British Guiana, Barbados Jamaica, and other islands of the British West Indies.

The injuries caused by this borer are much like those of the moth

borers but there are considerable differences in the life histories. The adult lives for a much longer period, sometimes for as much as six or eight months. The eggs are not laid on the surface but are deposited, one in a place, under the epidermis of the young internodes. The egg hatches in about six days, and the total life within the cane requires about seven weeks. The adults are stronger fliers than those of the moth borer, and they can emerge from infected seed when covered more deeply. They attack by preference the softer varieties of cane, and they are worse in wet than in dry districts.

Losses of over $150 per acre have been reported in Hawaii from this insect. Hand picking of the adults is often resorted to, and they are sometimes baited with split cane stalks scattered along the row in which the females deposit their eggs.

Bananas, coconuts, and some other crops are also attacked.

In Australia and Fiji, this borer is said to be usually held in check by the tachnid fly, *Ceromasia sphonophori,* which is supposed to have come originally from New Guinea. A tachnid was introduced into Hawaii by Muir in 1910. While it is doing good work, the control is not considered efficient. Other importations of parasites were not successful. Recently other tachnids have been brought from the Philippines.

Metamasius sericeus Oliver, the West Indian weevil borer, is a similar insect and does very much the same damage. With this, too, the eggs are deposited within the cane tissues. This borer is rather widely distributed in Cuba and the British West Indies, but it is only occasionally reported as doing serious damage. This would indicate that it was being held in check by parasites, but so far none seems to have been reported.

Like the Australian species, this also attacks bananas.

Metamascius hemipterus L., the Porto Rican weevil borer, is a very closely related species. This too occurs widely but seldom causes serious damage. Wolcott is of the opinion that it is really secondary, only ovipositing in injured cane.

Xyleborus perforans Woll., the shot-hole borer, is a small beetle occasionally found boring into cane stalks throughout the West Indies and in many other parts of the world. It is, however, clearly secondary, being found only in overripe cane and cane that has died from other causes. It is frequently associated with the rind-disease fungus, *Melanconium,* in the final breaking down of canes that are already dead.

Termites, or White Ants.—These insects, which are so common in the tropics and which cause so much damage by eating up soft

timbers used in building construction or in furniture, sometimes attack sugar cane also. A considerable number of species have been reported from time to time as causing such injuries. More often it is the seed pieces that are attacked in the soil and eaten up before germinating. Sometimes the stubble is attacked after the cane is cut. This, of course, prevents normal ratooning. Less frequently, the ripe standing cane is attacked and eaten.

Injury to the seed may be largely avoided by dipping the cut ends in tar before planting.

In the case of irrigated fields, flooding is advised if termites become troublesome.

A small wasp parasite, *Encarsia floroscutellum* Zehnt., has recently been imported to Java from Formosa.

Sugar-cane Mealy Bugs.—Two closely related species, *Pseudococcus Sacchari* Ckll., the pink mealy bug, often called *P. Calecolaria* Mask, and *P. boninsis* Kuwana, the gray mealy bug, are commonly found in most cane-growing districts. They are small, light-colored, soft-bodied, sucking insects which frequently congregate on the stalks in great numbers, usually under the bases of the leaf sheaths. The damage they do is largely disregarded but it is really very considerable, especially on poor lands and in dry weather, when they often become a contributary cause of root disease. In Louisiana, careful weighing of infested and uninfested canes, carried out during two seasons, indicated a loss of an average of 5 tons per acre as a consequence of mealy-bug infestation, and that too under conditions where such losses would naturally be considered as least serious. At one time, in Egypt, the variety POJ 105, the kind mostly planted there on account of its tolerance of mosaic, became so heavily infested with mealy bugs as seriously to threaten the industry, not only by loss of tonnage but by the fact that enough of the "honey dew" which is secreted by these insects was carried into the mills to interfere with the crystallization of the sugar. This variety especially favors mealy bugs because the sheaths hang so long on the matured stalks without falling, thus continuing to shelter the insects.

Mealy bugs are attended by various species of ants which care for them, moving them about from place to place where they can find a food supply, and cleaning them of excess honey dew which otherwise induces disease. The ants feed on this sweet secretion. Such a helpful association between different species is termed symbiosis in distinction from parasitism. In Louisiana the mealy bugs are more often attended by the introduced Argentine ant, *Iridomyrmex humulis.* As the result of four years' careful study

it was determined that the mealy bugs increased ten times as fast in areas where this ant was present as they did where it was absent. Furthermore, when the ants were controlled for three years over a large area by means of poisoned baits, the mealy bugs practically disappeared. (Barber, La. Bull. 185). In Cuba and Porto Rico mealy bugs are attended by the "fire ant" *Solenopsis geminata* Fabr., and in the latter island also by *Prenolepis fulva* Mayr. There are doubtless many other species that act in this manner in other countries.

Mealy bugs are easily transported to new fields on infested seed, and this is the way in which they have been so widely distributed. The females are wingless and do not travel after once settling down. The newly hatched young travel actively for a few days and run about over the stalk, looking for new tissue on which to settle down. It is doubtful, however, if they often pass unaided from one plant to another. They are grabbed up by the attendant ants and carried away to found new colonies in fresh pastures. In this way all parts of a new field soon become infested. Seed pieces may be cleared of mealy bugs by either the hot or cold water treatments mentioned in connection with the control of the moth borer. Where water is convenient, soaking the seed for three days before planting would doubtless be advisable when starting plantings in new districts.

Certain lady-birds are special feeders on mealy bugs. One such, *Cryptotæmus montrouzieri,* Muls., introduced from Australia to Hawaii some years ago is said to have been effective in reducing the number of mealy bugs. Attempts to introduce this species in Porto Rico and Louisiana do not seem to have been as successful.

The internal parasites of mealy bugs do not seem to have been especially studied. Doubtless such parasites occur, at least, they are known to be frequent in the closely related plant lice.

A yellowish-brown mould, *Aspergillus flavus* Link, is often found over-running groups of mealy bugs. Under favorable conditions of moisture, it is a fairly effective parasite and unquestionably destroys great numbers of the bugs, but they breed so rapidly and are looked after so carefully by the attendant ants that such disasters are quickly overcome.

Other Unarmored Coccids.—Various other soft-scaled and unarmored coccids related to the mealy bugs have been reported as attacking cane in different parts of the world. Usually they are considered to be of minor importance, but under special conditions any one of them might quickly become a serious pest, especially if by

chance it were introduced into a new country and its natural enemies were not brought in at the same time. The list includes the following:

Aclerda Japonica Newstead, India.
A. tokionis Ckll., Porto Rico.
Asterolecanium bambusæ Boisd., Madeira.
Icerga seychellarum Westw., Seychelles, Madeira, Formosa.
Leucanium guerinii Signoret., Mauritius.
L. Krugeri Zehnt., Java.
Margarodes formicarum Guild, Barbados.
Pseudococcus bromeliæ Bonché, Hawaii.
P. saccharifolia Gruen, Hawaii.
P. texensis Tonsley, Texas, Mauritius.
Pulvinavia iceryi Guerin, Mauritius, Formosa, British Guiana, Porto Rico.
Ripersia sacchari Guenée, India.

These are all enumerated here with the stalk pests although it is possible that some are found only on the leaves.

The Sugar Cane Armored Scales.—It is fortunate for the cane grower that these, which are everywhere among the worst pests of fruit trees and ornamentals, have never caused serious damage to cane. The few species reported are usually rare. It is probable that they are everywhere being held in check by parasites, but if so these parasites have not been studied.

Aspidiotus (*Odonaspis*) *secreta saccharicaulis,* Java.
A. (*Odonaspis*) sp., Cuba.
A. (*Targiona*) *glomerata* Guern., India.
A. (*Targiona*) *sacchari* Ckll., Cuba, Porto Rico, British West Indies, British Guiana, Java. This seems to be the only widely distributed species.
Chionaspis depressa Zehnt., Java, India.
C. mandumensis Zehnt., Java.
C. saccharifolia, Zehnt., Java.
C. tegalensis Zehnt., Java, Mauritius.

Sugar-cane Rust Mite.—(*Tarsonemus spinipes* Heret.) This is a very minute, almost microscopic, pale-green or pellucid mite that lives in large colonies on young cane internodes, protected by the leaf sheaths. Its punctures cause minute depressions in the epidermis which dry down and turn dark brown with age, giving the internode a peculiar brown, scaly appearance when exposed by the falling leaf sheath.

Presumably it is of wide distribution, but since it injures the cane very slightly it has received but little attention. It is very abundant in Porto Rico, especially on Crystalina and other light-

colored varieties. The dark-colored varieties, like Cavengirie, are seldom attacked by it.

While it is a pest of very minor importance, its effects are so conspicuous as often unduly to alarm persons who are not familiar with it.

The Mole Cricket, or Changa.—(*Scapteriscus didactylus* Latrx.) Although this is a soil insect, it should perhaps be mentioned here since its chief damage is not to the roots but to the young stems, which it cuts off, usually just below the surface of the ground. It occurs in various islands of the West Indies but has never attracted much attention except in Porto Rico, where it is often a serious pest. It is most troublesome in moist, sandy lands where it frequently prevents the securing of good stands. Some measure of control can be secured by the use of poisoned baits, but the usual method is to plant the seed nearly vertical on "changa lands," with one bud above the surface.

Other related species occur in other countries but they are nowhere else pests of much importance.

Land Crabs as Cane-field Pests.—In low-lying lands near the sea, land crabs are often very numerous and do serious damage by cutting off young cane shoots just above the ground. It is frequently very difficult to secure good stands of cane in these low-lying fields. The use of poisoned bait seems to be the only remedy. Phosphorus mixed in corn-meal mush is usually used, and a spoonful of this put at the mouth of each crab hole will soon clear a field of the pests. On the south coast of Porto Rico there are plantations where a number of men are employed all the year round who do nothing but poison land crabs.

Cane-field Rats.—Rats are a serious pest in cane fields in most parts of the world. They eat into the stalks of ripe cane, causing them to fall and rot. In variety plots it is always evident that rats are good judges of sucrose content, the richest and softest canes always being the ones worst injured. It is often difficult to find sound samples of some kinds for analysis, while canes in adjoining plots are untouched.

In Hawaii, in 1924, rat damage was estimated as reaching an average of 32.92 per cent, or almost one-third, in the fields under study. Other writers estimate the average damage in Hawaii at from 10 per cent to 15 per cent. These figures indicate sufficiently clearly the importance of the problem.

Rats are often trapped systematically on cane plantations. Some years ago the mongoose was introduced into various countries in the

hope of securing an efficient rat control. Unfortunately, the remedy proved worse than the disease, for the mongoose, tiring of a diet of rats, took to chickens and ground birds which it has practically exterminated.

Poisoning, too, has often been resorted to, but there is always danger in the promiscuous scattering about of ordinary poisons. In Hawaii a bait containing barium carbonate has been used satisfactorily (Exp. Sta. Rept. 1924, p. 25). This material is fatal to rats if eaten in any quantity but it is not dangerous to poultry or other farm livestock. The formula used calls for 1 part of barium carbonate to 3 parts of second-grade flour, sweetened with a half teaspoonful of saccharine to each ten pounds of material. Mix to a stiff dough and roll to thickness of blotting paper, cut into ribbons ¼ inch wide, and snip into pieces ½ inch long. Dry thoroughly in the sun or oven. These bits may be scattered through the fields by a man on horseback dropping one every 10 feet or so, but better results follow from establishing regular feeding places at about 50-foot intervals. These may consist of empty tin cans placed on their side and covered with a bit of tarred paper to keep off rain. Supplying these deposits once a month is said to give very satisfactory control.

In the writer's experience with household trials of this remedy, the rats soon tired of these baits and learned to avoid them. With the restricted diet of the cane fields, the gluten of the flower probably continues to attract them. Cane juice alone is not a well-balanced ration, and the rats seek to balance it by eating insects, even ripping up the bases of leaf sheaths to get at the mealy bugs hiding under them.

Root-feeding Cane Pests.—Next in importance after the insects that bore into the cane stalks are the large group of pests that live in the soil and feed on the cane roots. Besides many beetles and beetle larvae among the insects, such damage is also being done by nematodes, myriopods, and snails.

The Weevil Root Borer.—(*Diaprepes abbreviatus* L.) This insect should properly be included among the stalk borers, for although the larvae live under ground they do not feed on the roots but bore into the base of the stalk, causing damage quite similar to that of the weevil stalk borer, which they resemble in being large, whitish, footless grubs. The larvae of weevils are easily distinguished from those of other beetles by their lack of legs.

This borer (often called *D. Sprengleri*) is rather widely distributed in the West Indies, and locally it has caused considerable

injury both in Barbados and Porto Rico. It is not confined to sugar cane even in the larval stage, but may be found on other plants. The adults seldom feed on cane but prefer the foliage of various trees and shrubs. They are particularly fond of the pigeon pea, or gondul (*Cajanus indicus*), and it has been suggested that plantings of these along the roadways in cane fields could be used as trap crops on which to poison the borers. So far as recorded, this has nowhere been done on a field scale, and no other remedial measure has been attempted except the occasional hand picking of the adults. The spotted distribution of the insect suggests that it is usually held in control by parasites, but none seem to have been recorded.

Eggs are laid on the leaves and are protected by sticking two leaves together. When the young hatch they drop to the ground and burrow in for protection and to seek food. The entire life cycle requires about twelve months.

Cane White Grubs.—A number of species of root-eating larvae are known by this general name in all parts of the world. Next to the stalk borers, they probably do more injury than any other group of cane insects, and their underground feeding habits make them difficult to combat. Most of them belong to a rather closely related group of beetles, the larvae living on the roots of cane and other grasses underground, while the adults feed on the foliage of various fruit and shade trees.

The group as a whole is widely dispersed in all cane-growing countries, but the individual species are usually restricted in range.

A considerable number of parasites are known to attack the various species of this group and in the main they seem able to hold them fairly well in check. Really serious damage is reported only from south Porto Rico, Mauritius, and Queensland. In Hawaii the *Anomala* beetle has been successfully controlled by an introduced parasite. Various other attempted introductions have been made but nowhere else with really conspicuous success.

The following list is not complete but it will give some idea of the number of the more important species and of their distribution:

Adoretes helleri, Java.
A. versutus, Fiji.
Adoretes spp., Hawaii, Japan, East Africa.
Anomala sp., Hawaii, Japan.
Apogonia destructor R. Bos., Java.
A. retesmæ Sharp, Java.
Cycocephala villosa Burm., Louisiana.

Dyscinetus bidentatus, British Guiana.
D. picipes Burm., Cuba.
D. trachyphygrus Burm., Louisiana.
Holotricha helleri, Java.
H. videra Sharp, Philippines.
Lacnosterna antennata, L., Louisiana.
L. burmeisteri, Louisiana.
L. crassissima, Louisiana.
L. congena, Louisiana.
Lepidiota stigma, Hawaii.
Lepioderma albohirtum, Queensland.
L. caudata, Queensland.
L. frenchi, Queensland.
Leucopholis irrorata, Philippines.
L. rovida, Java.
Ligyrus rugiceps Lec., Louisiana.
L. tumulosus Burm., Porto Rico, Cuba.
L. zapedum Burm., Cuba.
Pentodon australis, Queensland.
Phyllophaga citri Smyth, Porto Rico.
P. guanicana Smyth, Porto Rico.
P. patruelis, St. Kits.
P. portoricensis Smyth, Porto Rico.
P. vandinei Smyth, Porto Rico.
Phyllophaga spp., Cuba.
Phytalis insularis Smyth, Porto Rico.
P. smithii Arrow., Barbados, Trinidad, Mauritius.
Ropæa subnitida, Fiji.
R. vestita, Fiji.
Serica assamensis, India.
Strategus anachorata Burm., Cuba, Porto Rico.
S. quadifoveatus, Porto Rico.
S. sarpedum Burm., Cuba.
S. titanus Fabr., Cuba, Porto Rico.

Where any of these insects has been especially troublesome, resort has frequently been had to hand picking either of the adults or the larvae or of both. While this has given some alleviation it cannot be considered as either an efficient or a satisfactory remedy.

The use of trap trees on which to poison the adults is advocated in Queensland. *Ficus pilosa* and *Ficus nesophila* are recommended for this purpose. They should be planted along the roadways and head lands. As the beetles only feed for about five days, spraying or dusting with lead arsenate must be properly timed.

Methods for combating white grubs have received very serious study in Queensland where these pests have long been an especially troublesome problem. Particular attention has been given to soil fumigants for destroying the larvae, and as repellants to prevent egg laying.

A number of materials have been used with some success, including carbon-di-sulphid, white arsenic, cyanide of potash, and cyanide of lime. Paradichlorbenzol, however, seems to have given the best results. It is recommended to apply from 100 to 300 pounds per acre in the planting furrow or in a furrow opened close to the ratoons. Wolcott, in Porto Rico, found it necessary to use a much larger qauntity, up to 800 pounds per acre, to kill all of the grubs.

The question of cane variety, too, seems to be of considerable importance, strong, deep-rooted varieties being conspicuously less injured than others. In Queensland, D 1135 is much more resistant than the local favorite, Badila.

The fact that white grubs are a serious problem only in certain restricted areas indicates that for the most part they are being controlled by parasites and other natural enemies. A very considerable number of parasites are known to attack them in different countries. It seems altogether probable that, with sufficient effort, importations could be made that would greatly aid such control where it is now lacking. Many such importations have been and are still being made. In the case of the *Anomala* beetle in Hawaii they have been quite successful. The problem is admittedly a difficult one but this seems the most logical line of attack.

Wire Worms.—This is a name usually applied to larvae of the snapping beetles, *Elateridae*. More or less serious damage has been reported from their feeding on cane roots in Cuba, Hawaii, Louisiana, and Queensland. No careful studies seem to have been made. In most cases, even the species causing the damage has not been determined and no suggestions have been given as to control. In some cases these larvae seem to bore into the base of the stalks. At other times they are reported as eating the root tips. They have been listed among the probable inciting causes of root disease. Clearly, here is a field that needs farther study.

Root Mealy Bug.—(*Ripersia radicicola* Morrison.) This insect, which is quite distinct from the species living on cane stalks, has recently attracted considerable attention in Cuba. So far it has not been reported from other countries. It lives on the roots of cane and various other grasses. Occasionally and in restricted areas it has become very numerous and has caused serious damage, sometimes

even killing out cane entirely. These bad spots are usually on poor lands, and it is still an open question whether or not the root mealy bug is likely to prove a serious pest on really good cane soils.

Apparently the insect occurs rather widely, at least on grasses, but it is only within the past few years that it has attracted attention as a cane pest.

Its presence on the roots causes much the same general symptoms that are usually referred to as "root disease," and doubtless the insect is one of the contributory causes of this trouble, especially on thin, dry, open soils.

Theoretically at least, the soil could be cleared of this pest by plowing up the bad spots and holding them under a leguminous cover crop for some months, since the insect does not feed on legumes but only on the grasses. So far, no other remedial measures have been suggested.

Root Nematodes.—The root-knot nematode, *Heterodera radicicola*, is a serious pest of many cultivated plants in the southern United States, especially on light, sandy lands. It is seldom troublesome on heavy clay soils. It is not often reported on grasses or other monocotyledonous plants. In south Porto Rico, however, it is causing serious damage to cane on some of the lighter, alluvial, sandy-loam soils of that district. The nematodes cause the usual galls or "knots" on the roots. The attacked plants are dwarfed in growth, and often show a characteristic golden-yellow discoloration of the leaves.

This nematode has been observed on all of the principal commercial kinds, including Crystalina, BH 10(12), and SC 12(4).

The subject of nematodes on cane roots has been given especial attention in Hawaii in connection with cooperative studies on root diseases. Some eight species have been found in or on cane roots, but without making galls, and some six other species in the ground near the roots.

Doubtless, these or other species are present in other cane-growing countries, and it is quite possible that they are a more important factor in the root-disease complex than has been supposed.

Centipedes on Cane Roots.—Centipedes of at least three different species have been observed feeding on cane roots in both Hawaii and Louisiana. They have in both localities been included among the inciting causes of root disease. Unfortunately, we know little of their abundance or of the amount of damage they are capable of causing.

The suggestion has been made that where irrigation is available such soil pests could be exterminated by flooding the land for a period

before planting, but no such usage seems to have been developed in practice.

Evidently, we know too little of many of the underground enemies of sugar cane.

Snails as Cane-root Pests.—Rands, in Louisiana, seems to have been the first to call attention to the work of a small snail, *Zonitoides arboreus* Say., as a serious root pest of sugar cane. He is inclined to believe that it is one of the principal causes of "root disease," especially on the heavier soils of Louisiana. The damage caused by it seems to be greatest in winter and early spring and is particularly serious on fall plant cane, since the snails keep the young rootlets eaten off so closely as to impede germination and to induce much rotting of the seed.

At least three species of snails have been found feeding on cane roots in Hawaii, and one such case is reported from Cuba.

Here again, we know too little about what is going on under ground. So far no practicable remedies have been proposed for these supposedly minor underground pests. Doubtless, if sufficient necessity should arise to warrant the expense, they could be controlled by some such system of soil fumigation as has been worked out by the Australians for controlling the white grub.

Leaf Feeding Cane Insects

Most of these may be conveniently considered under two headings: the leaf-sucking insects, and the leaf-chewing insects. There are, however, a few small and relatively unimportant groups that neither suck nor chew. They scarify the surface but do not eat holes in the tissues and do not puncture the deeper tissues. Among these should be grouped the following:

Sugar-cane Leaf Mites, or Red Spiders.—The occurrence of five or six species has been recorded in Cuba, Java, Louisiana, and Porto Rico, but nowhere are they of more than very minor importance. They sometimes cause large reddened areas on the older leaves. Frequently, their minute scarifications seem to be the beginning of the so-called "ring spot," which is so common on the older cane leaves.

No remedies have ever been needed or suggested. In case of need these insects could doubtless be controlled by dusting either with nicotine dust or sulphur, but it is quite improbable that this expense will ever be justified.

Springtails as Sugar-cane Leaf Pests.—The mosaic outbreak in Porto Rico caused a determined search among the less-known and inconspicuous cane insects with the hope of finding the insect vector of this disease. The results of this work were brought together by Wolcott in his paper on "The Minor Sugar Cane Insects of Porto Rico" (Jour. 5(3), 1921).

One of the unexpected by-products of this study was the discovery that the one most abundant sugar-cane insect in Porto Rico had never even been noted by any of the eminent entomologists who had studied sugar-cane insects in that island, and that, when it had been found, none of the specialists could venture to name it. An undescribed species belonging to the *Thysanura,* or springtails, is still as far as we can go.

This minute insect is present, literally by the million, in every cane field in Porto Rico, living, all stages together, on the lower side of the older leaves, or in very dry weather retreating into the enrolled bud spindle. Its minute scarifications are the immediate cause of most of the "ring spot" which is so common there on the older leaves.

Such an oversight as this, of a very common, injurious species, can only be explained by the common and pernicious practice of assigning experiment station workers to too narrow a line of "projects." If a man is studying borers or white grubs, how can you expect him to see springtails, especially where all the authorities agree that no such animal exists on cane?

Thrips on Sugar Cane.—This group of insects, which are so serious a pest on other crops, seldom cause appreciable damage to sugar cane, although they have been reported as occurring on it in Cuba, Louisiana, and Porto Rico. A yellow species was at one time very abundant on young cane in certain fields in south Porto Rico, occurring in great numbers in the enrolled terminal spindle. Since the year in which it was observed in such numbers, it has not been abundant enough to attract attention.

Leaf-sucking Insects.—These naturally fall into two groups: the aphids, or plant lice; and the leaf hoppers.

The Corn Aphis.—(*Aphis maidis* Fitch.) Curiously enough, this aphid must be given the first place in this group as a cane pest although, strictly speaking, it is not a cane insect at all. It seldom or never breeds on cane, and it only feeds on it under compulsion, and yet it has been absolutely proven that this insect is the usual carrier of mosaic to cane, and the cause of that so-called secondary infection which makes this disease so difficult to control. The fact

that this insect was a carrier of mosaic was first demonstrated by Brandes in the greenhouses at Washington. This epoch-making discovery did not convince the workers in Porto Rico that the corn aphis could be the usual carrier in that island, for after years of search none of them had ever seen a corn aphis on a cane plant. Wolcott, in the report on "The Minor Cane Insects" already referred to, says, under this species (p. 34): "The corn aphis has not been found on cane in Porto Rico. It cannot in any way be considered responsible for the transmission of sugar-cane mosaic under field conditions in Porto Rico"—a statement with which all of his colleagues, including the present writer, were in perfect accord. It was shortly after publishing the above statement that Wolcott himself first found the corn aphis feeding on cane. A field grown up with clumps of grass on which aphids were feeding was being cleaned with the hoe. The insects were leaving the wilting grass and climbing up and feeding on the cane. With this as a clew, the brilliant experiments of Chardon and Veve soon demonstrated that this was the real cause of secondary mosaic infection, and thus ended a four-year search for the carrier of mosaic disease in Porto Rico.

Were it not for this fact, this insect would be absolutely negligible in the cane fields. Its normal hosts are corn, sorghum, and various grasses, on all of which it breeds freely. Its feeding on cane is purely accidental.

Like other aphids, it is preyed upon extensively by lady-birds and by certain syrphid fly larvae. It is also attacked by an internal braconid parasite, and in most weather it is extensively attacked by entomogenous fungi.

Theoretically, it could be controlled by nicotine dusts. It is doubtful if this is ever attempted on a field scale on account of the expense. Complete control of aphids by dusting is recognized as very difficult, and partial control is already afforded by the many natural enemies.

The Yellow Cane Aphis.—(*Sipha flava* Forbes.) This is a common cane insect in Porto Rico. Apparently it is less common in Cuba and has only been reported once in Louisiana. The insects feed on the lower surfaces of the older leaves, and not in the terminal bud spindle as is the habit with most other species. They cause a conspicuous red-and-yellow speckling of the leaves which is quite characteristic and easily distinguished from other insect spottings. Usually the injury caused is not serious, but occasionally a field is seen that is clearly injured. Uba and its relations are more likely to suffer seriously than the noble canes.

Like the other aphids, these insects are attacked by lady-birds,

by syrphid fly larvae, and in Porto Rico by a black-and-yellow spider, *Theridula triangulata* Keys. These and other natural enemies usually serve to hold them fairly well in check. No artificial remedies seem to have been attempted.

Other Cane Aphids.—Various other species of plant lice have been reported on cane in different countries, but they do not anywhere seem to be pests of major importance and they are usually kept under fair control by their numerous natural enemies.

Hawaiian Leaf Hopper.—(*Perkinsiella saccharicida* Kirkaldy.) This has caused far greater damage than any other insect of this group. It was introduced into Hawaii from Queensland at some time prior to 1900, and unfortunately came without its native parasites which control it so well in its home country that it has never been a serious problem there. In Hawaii it increased so rapidly that it was soon seriously threatening the life of the industry. Eggs are laid in cavities in the midribs, or sometimes in the leafsheaths and internodes. They hatch in about two weeks, and the adult stage is usually reached in less than two months. As the nymphs secrete honey dew, the attacked plants are soon covered with sooty mould. The leaves dry up prematurely, and finally the terminal bud often dies, forcing lateral sprouting. Such severe cases are usually accompanied by rind disease which may finish the job by killing the cane.

A considerable difference in varietal resistance was noted, Lahaina and Rose Bamboo being injured more severely than Yellow Caledonia which showed more resistance than any of the kinds then in cultivation.

In 1904, Koebele and Perkins sailed for Australia in search of parasites. They succeeded in introducing a number of parasites and preditors with such success that at the present time the cane leaf hopper is a rare insect in Hawaii and has long since ceased to be a factor in the sugar industry. This was an outstanding triumph for the entomologists, and it has stimulated and still is stimulating similar work in all parts of the world. Its remarkable success was due to the fact that the insect in question was an imported one which had chanced to arrive without any of its natural enemies. It is seldom that conditions are such that the introduction of parasites will give results as sweeping as these. This balance in nature between a dangerous insect and the parasites that hold it in control is so delicate that slight changes in conditions may tip the scales one way or the other, either to cause serious losses or so to minimize them that they become negligible. This fully justifies the efforts to bring in new parasites, even in cases where fairly efficient ones already

exist. The newcomer may succeed in turning the balance in our favor.

For the same reason, cultural practices should always be reviewed to see what bearing they may have on the problem. For instance, certain egg parasites proved to be the most effective of those introduced to fight the leaf hopper, but Perkins noted that they were being greatly damaged by the prevailing custom of burning over the fields. This practice of burning the trash, like so many other agricultural customs in the cane fields, is usually based on tradition rather than on any real, well-thought-out reason. In some countries it is the custom to burn trash, in others it is not. In most cases no real reason can be given for these differences in practice. Plausible arguments can be given for either custom, and each has obvious advantages and disadvantages. Either plan is perfectly practicable, as is proven by world-wide experience. If burning trash, or any other practice, can be proven to be damaging valuable parasites, let us change the practice. There is nothing to prevent the change except inertia and prejudice.

The West Indian Cane Leaf Hopper.—(*Delphax saccharivora* Westw.) This insect is widely distributed in the West Indian region. Its habits are much like those of the Hawaiian leaf hopper, and when abundant it causes very similar injuries. Being indigenous to the region, it is attacked by a number of parasites and preditors which usually hold it in check quite effectively. In Jamaica and sometimes in some of the other islands, it occasionally causes considerable injury.

It is reported from Haiti (*Facts about Sugar*, Jan. 29, 1927, p. 106) that dusting with calcium cyanide has given quite complete control. Two applications were made, about a week apart. The use of this dust on a large scale would be attended with some danger since it gives off the very poisonous fumes of hydrocyanic acid. It is not stated whether or not the nicotine dusts might not give equally good results. In any event such dusting would only be a local emergency measure since in the long run the insect is quite sure to be controlled by its natural enemies.

Other Sugar-cane Leaf Hoppers.—A very considerable number of other species of leaf hoppers have been reported as feeding on cane in various parts of the world. They have nowhere been considered as major pests but they have been looked upon with suspicion as the possible carriers of cane disease. This has largely been suggested by their known disastrous effects in spreading the "curly top" disease of sugar beets. Much effort has been given, especially in

Porto Rico, to the attempt to connect some one of them with the spread of sugar-cane mosaic, but so far without the slightest success. It seems to be conclusively proven that leaf hoppers do not carry sugar-cane mosaic. It is interesting to note, however, that the closely related streak disease of South Africa is conveyed by one of them, a small species of *Balclutha,* and that one of the corn mosaics, formerly confused with cane mosaic, is conveyed by the corn leaf hopper, *Peregrinus maidis* Ashm.

Some twenty other species of leaf hoppers are reported on cane in Porto Rico by Wolcott. Doubtless many other countries have an equal number, and yet nowhere are they doing any serious damage because everywhere they are being held in check by their natural enemies. While perhaps it cannot be proven, there is every reason to suppose that almost any one of them might develop into a serious pest, as did the one in Hawaii, if by chance it should be carried to some new country without these natural checks.

The Trinidad Frog Hopper.—(*Tomaspis varia* Fabr.) The so-called "frog hoppers" are a group closely related to the leaf hoppers but they may be distinguished by the layman from the fact that the nymphs secrete a kind of froth, or spittle, in which they lie concealed. Several species are known on cane in various parts of the West Indian region, but they have nowhere attracted attention as a pest except in the Island of Trinidad where they are really very serious. They have already been mentioned in the paragraph on Trinidad or frog-hopper blight, a trouble which they are supposed to cause, but which is probably better considered as only a form of root disease.

This insect has been long studied and there is a considerable literature regarding it. No really satisfactory control measures seem to have been worked out. Quite recently it was stated that dusting with calcium cyanide gave a fairly good control, killing over 80 per cent at a cost of about $8.50 per acre. The general use of this dangerous poison cannot be safely recommended.

Since closely allied species exist in neighboring countries without causing serious damage, the presumption is strong that they are being held in check by parasites. The continued search for and introduction of these may ultimately solve Trinidad's most serious cane problem. It is an attractive one for the new Imperial College of Tropical Agriculture.

Leaf-Chewing Insects

Among the insects that eat the tissue of cane leaves, one small group must be set apart on account of their habit of eating out the internal parenchyma of the leaves in considerable areas without destroying the upper and lower epidermis, which serves to shield them. These are as follows:

The Sugar-cane Leaf Miners.—The larvae of at least two small species of beetles are reported as doing this kind of work in Java. Apparently they are only minor pests.

Leaf-chewing Beetles.—A few small beetles are known to feed on cane leaves in different countries. These include the flea-beetles, the green *Diabrotica*, and a few others. None of them seem to be of serious importance.

Leaf-cutting Ants.—(*Atta insularis Guerin.*) The parasol ant, or "bibijagua," is a very common insect in Cuba. Its mounds are frequently found in cane fields but the insects seldom trouble the cane plant. Occasionally, however, the leaves will be cut away from a number of plants near a mound and the pieces carried down to the underground galleries where they are packed together until they ferment and are over-run by fungi, on the spores of which the ants feed. These remarkable insects do not eat the cane leaves but use them in their underground fungus gardens. If these ants should ever develop a real fondness for cane they would at once become a serious pest. Fortunately, they only seem to use cane leaves as a last resort.

Grasshoppers.—A very considerable number of species of grasshoppers or locusts have been found feeding on cane in many different countries. This is mostly incidental. None are known that are confined to cane as a food. Ordinarily the damage done is of no great moment, but in countries where there are great migrations of grasshoppers it may be very serious indeed.

The modern method by which arsenical poisons can be quickly dusted over great areas by means of airplanes would seem to be exactly suited to meet such an emergency. The technique has been completely worked out and is being used on an extensive scale in the southern United States to combat the cotton boll weevil. Either grasshoppers or the various leaf-eating lepidopterous larvae to be discussed in the next paragraph can quite certainly be fully controlled by this method whenever losses are heavy enough to justify the expense. As has been stated before, an airplane is the only means by which dusting would be practicable in fields of full-grown cane.

Cut Worms, Grass Worms, and Leaf Rollers.—These names and others are applied to various lepidopterous larvae which eat cane leaves in all sugar-cane-growing countries. Most of them, like the cut worms and army worms, are the larvae of moths, but a few, the so-called skippers and *Calisto pulchella* of Santo Domingo, are true butterflies.

At times some of these many species get away from their natural control and do serious damage. For the most part, however, they are fairly well held in check. In Hawaii additional parasites have been imported with notable success.

It is very clear that, like the grasshoppers, all of these leaf-eating larvae can be controlled by airplane dusting with the arsenates whenever losses are sufficiently great to justify it. This, however, is always in the nature of an emergency remedy. Ordinary control should be sought by aiding the natural enemies of the pests.

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Part Two

THE CULTIVATION OF SUGAR CANE

CHAPTER VII

CLIMATE AND SOILS

Sugar cane is a crop with very simple agricultural requirements. If this were not so the world would be short of sugar, for there are few large-scale crops that are grown by such crude, antiquated methods. There are, it is true, a few districts where sugar-cane agriculture has been highly developed, but the above statement holds true for by far the greater part of sugar-cane production. The view seems to be widely held that crude methods are cheap, and that improved methods are necessarily more expensive. This may be true in part if we look only at costs per acre; but no method can be considered an improvement that does not lead to cheaper costs per ton of cane, or better, per pound of sugar produced. There are times when special market conditions might justify greater production even at an increased cost per unit; but, generally speaking, and especially when the industry is passing through a crisis due to low prices, the only criterion by which to judge of cultural methods is by their effect on the cost of production. This is a truth which cannot be seriously questioned; yet it is strangely overlooked, not only by most plantation managers but even by some who are in the position of leaders of thought in the industry. Let us repeat: no change in existing agricultural methods is justifiable unless it leads to the cheaper production of sugar. That is the central underlying thought around which this book is written.

Climatic Conditions Suitable for Sugar Cane.—Sugar cane is a tropical plant. It can be grown successfully in all parts of the tropics where sufficient moisture is available, either from rainfall or from irrigation. Where the average rainfall reaches 50 inches per year, it can usually be grown satisfactorily without irrigation; but where the rainfall is much under this figure, additional water will usually be required to obtain profitable yields. In many of the regions of comparatively scanty rainfall where cane is now grown without irrigation, production costs could be decidedly lowered by going to the expense of providing water for a few irrigations at critical periods, simply as a supplement to the natural rainfall. Just how

much water a cane crop can use profitably has been widely discussed, but it is difficult to give general figures that would be of value since so much depends on local conditions. With rainfall alone, 100 inches a year, if properly distributed, will usually give as good or better results than any greater quantity.

The seasonal distribution of the rainfall is almost as important as its total quantity. Climates with a pronounced wet and dry season are much better for sugar cane than those where the rainfall is equally distributed throughout the year. Abundant rainfalls are needed for growing the crop, but comparatively dry weather for ripening and harvesting it. The 50 inches per year mentioned above as a satisfactory minimum—and this, by the way, is about the average for the island of Cuba—would be entirely inadequate if equally divided among the twelve months. In Cuba, by far the greater part of it falls during the period from May to October, leaving the rest of the year dry for the harvesting.

While the sugar-cane industry is typically a tropical one, it is not strictly confined to the tropics. Such important cane districts as those of Louisiana and Argentina are well outside of the tropics, and both experience freezing weather, sometimes of considerable severity. Since the buds of the growing cane are killed by even a slight freeze, it is necessary to protect the stalks intended for seed by cutting them early before danger of frost, and piling them on the ground in windrows which are protected by covering with cane trash and earth. In the early spring before the weather is warm enough to cause sprouting, these windrows are opened and the seed planted. The standing cane can still be utilized for the mill after the buds have been killed by light freezing. A heavy freeze, however, renders it worthless, so that the harvest has to be hastened as much as possible, thus making a very short grinding season. The worst drawback, however, in these climates is that all the crop has to be made on immature cane. In Louisiana, 8 or 9 per cent in sugar on the weight of cane is considered a good yield, while in Cuba, with mature cane, the average yield is over 11 per cent and sometimes reaches 13 per cent.

A freeze sufficient to kill the standing cane does not injure the roots, and such fields can be ratooned, although fewer ratoon crops are usually taken in extra-tropical regions.

By carrying over the seed cane in windrows, as described above, and planting every year, cane can be grown for syrup making much farther north than for sugar. The juice from immature cane does not crystallize well but it makes a good grade of syrup. There is

a considerable syrup industry in southern Georgia, Alabama, and Mississippi, in districts where zero temperatures sometimes occur, and where there is heavy freezing every winter.

Sugar-cane Soils.—Cane can be grown successfully on a great variety of soils. Typical cane lands, however, are heavy rather than light in texture. Good clay loams and rather heavy alluvial soils are among the best for this crop. Much good cane is also grown on sandy loams, but usually the lighter grades of this type are better reserved for other crops. Of course, much depends also on the nature of the subsoil. A fairly light top soil, if underlain by a good clay subsoil, will be very satisfactory for cane. Very heavy top soils, on the contrary, are better if the subsoil is somewhat open, since this makes for better drainage, which is a matter of first importance. Different types of soils often require widely different systems of planting in order to secure the best results. This important matter will be discussed in detail on another page. Again, cane soils can hardly be discussed intelligently without at the same time considering cane varieties, since the different kinds vary widely in their soil requirements. In the discussion of varieties in a previous chapter, some indication was given as to the type of soil to which each is best adapted. This is a matter of the greatest importance, but it is not sufficiently understood by most plantation managers. The tendency usually is to make some one or two favored kinds the basis of the industry in entire districts, with no regard to their adaptability to the varying soil conditions. It is safe to say that on many plantations average yields could be increased 20 to 30 per cent simply by selecting the variety best adapted to the soil of each of the fields, and this of course at no additional cost.

In the following paragraphs a brief discussion will be given of some of the principal sugar-cane soil types, but they will be considered from the standpoint of cane agriculture rather than of soil physics.

The Red Lands.—The so-called red lands occupy extensive areas in the tropics and are everywhere well adapted to the growth of sugar cane. They are all rather closely similar in agricultural characteristics, being sticky and plastic when wet, but, unlike true clays, being open and porous in structure so that water passes down through them readily and there is no drainage problem. There is no well-marked subsoil. These soils may be shallow or very deep, but they go down practically unchanged in structure to the bed rock. The red color is due to iron which is present in large quantities, usually from 6 or 8 per cent to as high as 20 per cent. The lime content is low and sometimes deficient. Nitrogen, phosphoric acid, and potash are at

first abundant. These soils are very fertile and productive when new, but, owing to their porous structure and the ease with which water passes down through them, they leach much more rapidly than is usual for such heavy soils, and after eight or ten years of cropping they usually begin to need fertilizers. Very often, phosphoric acid is the first of the manurial substances to become exhausted. These red lands always respond readily to applications of chemical fertilizers, but one of their greatest needs is care in keeping up the supply of humus as an aid in holding moisture. The burning of trash should be avoided wherever possible. Drought is one of the greatest enemies of these soils. They are easy to cultivate since water sinks so rapidly that it is usually possible to work them the day following a heavy rain, but unless rains or irrigations come frequently the crop soon suffers. On the other hand, in case of a really severe drought, crops on the red lands often hold out better than on clay loams which hold moisture so much better during a short dry period.

It is hard to describe these lands in the terms of the usual soil nomenclature. They clearly are not clays or clay loams, at least from an agricultural standpoint, although they would probably be so classified by anyone walking over them when wet. No clay can stick to the feet more successfully, but a few hours later this sticky mud will have dried out so that it crumbles beautifully on passing a cultivator. A mechanical analysis classifies most of the material as "fine silt" though there is some sand and a little true clay.

Although so closely alike in cultural characters, the red lands include at least two types of widely different origins. The so-called laterites are supposed to be formed from the breaking down of various igneous or volcanic rocks. This name is sometimes applied to all the red lands, but, in the West Indies at least, there are great areas that seem to have been formed from the weathering of coral limestone with the dissolving out of the calcium carbonate, leaving a residue which is rich in iron but very low in lime. At least, these lands are always underlain by coral limestone, and wherever reefs of this material are exposed the process of weathering and the accumulation of pockets of red soil can be observed.

The outstanding characteristics, then, of the red lands are their perfect drainage, their ease of cultivation, and their adaptability to a wide range of crops. There are very few tropical products that cannot be planted successfully on the red lands. They present very few agricultural problems, the only serious one being that of maintaining fertility.

Black Lands with Clay Subsoils.—These are another important factor in sugar-cane production. They are heavy clay loams, often rather shallow, and the subsoil is very impervious. As they are usually low and flat, proper drainage presents the most important and, many times, a very difficult problem. In many cases these lands seem to have been old sea bottoms that have gradually silted up until mangroves could become established. These mangrove swamps are continually filling up slowly with débris and silt until finally other vegetation is enabled to establish itself.

Such soils are potentially very rich. When first cleared of forest and planted to cane, they yield splendid crops; but with the rotting out of the tree roots, which at first furnish a kind of drainage, they become badly compacted and suffer seriously from standing water and lack of aeration. These are ideal conditions for the development of "root disease," which only too often puts a premature end to the plantings. These are potentially among the richest of all cane soils, and with proper handling they are capable of the longest continued production, yet where their agricultural problems are not clearly understood they are frequently abandoned as cane fields and turned into pastures. The proper handling of these soils will be discussed in another chapter.

There are some hill lands that would naturally fall under this heading since they are heavy, black clay loams with clay subsoils. Their origin is quite different, since they are usually produced *in situ* by the weathering of certain local rocks. Their topography is such that drainage is easy, or perhaps not required, and they are everywhere recognized as among the best of cane lands.[1]

Black Lands with Calcareous Subsoils.—In certain districts these are an element of great importance in sugar production. Cuba, in particular, has large areas of these lands, and they are especially noteworthy for the richness of the cane produced on them. The top soil is a loam or a clay loam, but it is never as stiff and intractable as the black lands discussed in the last paragraph. Where it is of sufficient depth, say from 8 to 12 inches or more, it is very productive, and retains its fertility for long periods of continued production. In some cases it is quite thin, often as little as 3 or 4 inches. Such soils are more difficult to handle and lose their fertility more quickly. The subsoil is a whitish, soft, marl-like material that is often nearly pure carbonate of lime. At other places it is somewhat mixed with

[1] A recent soil survey of Cuba classes these lands as clays. Whatever the size of the soil particles, they are not clays as this term is usually understood.

clay, but carbonate of lime always predominates. The so-called "rotten limestone" soils of Alabama and Mississippi are of the same general character.

Sometimes these lands are pretty flat, but usually they are more or less rolling so that the drainage problem is not serious. Usually all that is required is a few run-off ditches to clear the low spots. Such soils hold moisture well and are easy to cultivate. Take it all in all, there are no better cane lands anywhere than the best and deepest of this type. A little care, however, is necessary in the selection of varieties. Some kinds suffer severely from chlorosis, especially in the young ratoons.

Brown or Mulatto Clay Loams.—This group includes a considerable variety of soils of widely differing origins. Perhaps most often they are formed *in situ* by the weathering and breaking down of shales. They do not even agree in color, being sometimes yellow, more often brown, but not infrequently red or reddish brown. Some members of the group carry an admixture of gravel consisting of small, rounded pebbles of bog iron ore. Sometimes but little change can be noted in the subsoil, but usually these soils are underlain by even more retentive clays, making drainage very necessary. The top soil is always a clay loam and is usually stiff and intractable, though by careful handling it can be gotten into a good state of tilth.

Large areas of these lands are in cane in different countries, but it is everywhere recognized that they are more difficult to handle, and less desirable, than the other types that have been discussed. Many of them respond well to chemical fertilizers, but all require the utmost care in keeping up the supply of humus-forming vegetable matter on which their friability and tilth so largely depend. The field manager who handles large areas of these lands will have his agricultural skill and knowledge taxed to the utmost, but, on the other hand, there are few classes of cane land where this skill will give larger returns. The difference between good farming and poor farming on these lands is the difference between success and failure.

Alluvial Lands.—These are soils deposited by running water. They constitute the river and creek bottom lands, and sometimes form considerable areas at the foot of ranges of mountains, as on the south side of Porto Rico. They are of variable texture but are usually lighter and more open than the soil types discussed above, from a greater or less admixture of sand, and would be classed as loams, or sometimes even as sandy loams. They are everywhere recognized as among the best and most productive of agricultural lands. The fertility of river bottoms is proverbial. In many countries they are an

important factor in cane production. The Louisiana cane lands are all alluvial. In Cuba, on the contrary, the area of such lands is very limited.

These lands are easy to cultivate and usually retain fertility for long periods. Sometimes they need drainage, but often there are underlying strata of gravel which carry off surplus water. The higher benches, or second bottoms, are usually very well drained.

These lands, too, are adapted to a wide range of varieties. Almost any good cane will grow well on alluvial lands. Even the old, abandoned Otaheite will still give fine yields on such soils since their open and porous but moist nature is just what this old favorite requires. It is the hard, compact, poorly aerated nature of most cane soils that caused the abandonment of this once famous cane.

Sandy-loam Soils.—These are not typically cane lands, although in some districts considerable areas of them are planted to cane. They are easy to cultivate and respond well to fertilizers, which are usually required to keep up profitable production. Some varieties fail on these lands, but others are proving to be well adapted to them. The ease and cheapness of preparation and the ease of cultivation are factors which will largely offset the extra cost of fertilizers, and it seems certain that a permanently profitable cane industry can be maintained on lighter soils than have usually been considered as cane lands. To do this successfully, however, will require better agricultural methods than are usually found in the cane fields, and good judgment in the selection of appropriate varieties.

CHAPTER VIII

PREPARATION OF THE SOIL FOR PLANTING

In sugar-cane literature a certain confusion exists as a result of varying usages of the word cultivation. In some countries the word is used to include all the operations connected with the growing of the crop. In the United States, however, the term is usually restricted to the work done between the rows of growing cane, so that such expressions as "good cultivation with a Fowler steam tackle" sound incongruous to American ears. It would be better to use the term tillage for the work done after the cane is planted, but the other usage is firmly established. Since the preparation of the land for planting and the subsequent cultivation of the crop are quite distinct operations, and usually require different equipment, they will be discussed separately here.

The amount and kind of preparation given to cane lands is exceedingly variable. On new timber lands it is practically nothing beyond the cutting and burning of the timber. Stakes are set to guide the planters, and holes are made with a sharpened stake, a crow bar, or a pick, and a piece of seed cane inserted. On the best lands, such crude plantings will continue to give crops for fifteen or twenty years, when it becomes necessary to abandon the fields and plow them to prepare for a new planting. This is when sugar-cane agriculture and the troubles of the agriculturist really begin. The first planting is exploitation rather than agriculture. It is perhaps an open question if in the long run it would not be better and cheaper to dig the stumps and properly prepare the land in the first place, but as a matter of fact this is seldom or never done for cane planting.

Formerly, when animal power was depended on for plowing, it was customary to leave the big hardwood stumps standing, and to do this first plowing and preparation between them. This is never fully satisfactory, but with walking plows and old-fashioned V-shaped tooth harrows it is perfectly practicable so to prepare such lands as to make planting possible. With the advent of tractors and steam plow tackle, such makeshift measures are no longer possible, and it is necessary to clear the land completely of stumps before plowing. This is usually

done by pulling the smaller stumps with tractors and using them as fuel for burning out the big ones. Before trying to burn out a stump, the dirt should always be dug away enough to expose the crown fully.

In preparing cane lands with walking plows, it is usually necessary to plow them twice, or sometimes three or more times, with sufficient intervals between for weathering. They are usually so hard and intractable that it is impossible to get them into a satisfactory state of tilth without repeated workings. If properly used, a disc harrow can often be made to take the place of one or more of these plowings with equally good results, and at a considerable saving in costs. The use of this really most important implement is often poorly understood in the cane country. On hard land in dry weather, to be used effectively, it must follow close behind the plow. Once the big lumps turned up by the plow have dried in the sun, the disc will bounce off from them without cutting; but when freshly turned they are usually easily sliced to pieces. When three or four rigs are being used in the same field, one should always have the harrow and follow close behind the plows. The ordinary two-gang disc harrow should always be driven with a half lap. Used in this way, it goes over the surface twice, and keeps the land level. With the big four-gang tractor harrows, this double work is not so necessary. In plowing with a big tractor and a four or five disc gang plow, it is sometimes possible to hitch a four-gang disc harrow on behind the plow, and thus do both plowing and harrowing at the one operation. More often it is better to let a small tractor with the harrow follow the big tractor with the plows. This combination of large and small tractors on the same job works out very conveniently, the big tractor doing the breaking, and the small ones finishing the job by harrowing and furrowing for planting.

On some types of heavy cane lands this prompt work with disc harrows is not needed, since the soil has the property of cracking and crumbling when exposed to the sun, even in the driest weather. Such lands can be plowed and left rough, and after two or three weeks can be knocked to a powder with an ordinary tooth harrow.

In preparing land during the rainy season, the problems will be quite different. Some soils can be stirred when quite wet with no apparent injury, while with others great care is necessary not to puddle them and spoil their texture for the whole season. The red lands and others which dry out quickly are best prepared during the rainy season, but the low-lying black lands are often so wet that it is impossible to touch them until the rains are over.

Many cane lands are so sticky and have so little grit that ordinary mouldboard turning plows do not scour well. Cross plowing is especially difficult on such lands, the plow dragging through them without opening a clear furrow. In such cases the use of the disc plow is indicated, since, with the proper adjustment of the scrapers, this can be made to clear itself and throw a good furrow in any soil, no matter how sticky. For turning under trash, weeds, or cowpeas, the disc is also more efficient. This is especially true for tractor gang plows, since turning plow gangs give much trouble from choking when there is much trash of any kind on the ground.

With the advent of cable-drawn steam plows and their ability to turn the land to much greater depths than had previously been possible, the question of the proper depth for plowing has been much discussed. This ability to plow deep was taken up as good selling talk by the plow manufacturers, and its importance has been overemphasized. Unquestionably there are some lands, particularly the red-land types, where these big plows can be driven down to the limit of their capacity without doing permanent harm, but even on these most favorable soils it is doubtful if such overly deep plowing really pays. On thin, black lands, on the contrary, especially on those with clay subsoils, big steam plows in the hands of over-enthusiastic plowmen have often proven a real disaster, since it has taken many years for the fields to recover their productiveness after the turning up of the raw subsoil. It is a safe rule never to allow the plows to turn out over an inch of the subsoil at any one plowing. By working in this way, especially if the turning of the soil is accompanied by the plowing in of green manures, the depth of the soil can be slowly increased with safety.

Even on deep soils, it is unwise to plow too deeply at the beginning of the dry season unless the fields are to be irrigated. Plowing destroys the capillarity of the soil, by means of which moisture is brought up from the lower subsoil. This is only restored when the soil is partially compacted again by rains or by irrigation. With moderately deep plowing, especially where the furrow slices have been properly fined and compacted by a sufficient use of the harrow, capillarity can still bring the soil moisture up within reach of the roots of the young cane. With very deep plowing this is not the case, and the young plants suffer. Of course, these considerations do not hold at the beginning of the rainy season, when the deep plowing may be an advantage in furnishing some measure of temporary underdrainage. Ordinarily speaking, however, reducing the upper 8 or 10 inches to a condition of fine, mellow tilth is of far more importance

to the coming crop than anything that can be done at greater depths. This can best be done by the successive use of different kinds of harrows, and it is here that the big steam tackles are usually weakest. They are poorly supplied with harrowing implements, and it is difficult to reduce stiff, intractable soils to a proper condition of tilth without the aid of occasional rains to help break down the clods. Steam plows are unquestionably of great assistance on large cane plantations, but they should be used intelligently, and by some one with a real knowledge of the agricultural needs of the different soils. One of the implements coming with these rigs that is usually not sufficiently appreciated is the "knifer," or subsoiler. Where it is considered advisable, for any reason, to stir the ground deeply, it is usually much better and safer to do it with this implement, rather than to put down the big turning plows to their full depth, with the usual great clods of raw soil which require so long to weather into tilth and usefulness. Knifing and cross knifing, followed by disc harrows drawn by tractors, will often leave a much better seed bed than can be made with the steam turning plows, and this is a kind of steam-plow preparation that can be safely used even in shallow lands, since the subsoil blades break up and loosen the subsoil without bringing it to the surface.

Within recent years an entirely new type of plow has been devised by Mr. N. C. Storey, formerly of Porto Rico, where he was employed on one of the big plantations to supervise the steam-plowing outfits. He had seven of these big rigs under his care, and it was to overcome some of the inconveniences encountered in their use that he devised the new implement. It consists of a powerful gasoline engine mounted on caterpillar wheels and geared to drive two 5-foot, revolving discs at the rear of the machine. Each disc carries four turning plows. They can be raised in turning at the end of the row and instantly lowered to any desired depth, and, as the discs revolve much faster than the forward movement of the plow, a grinding motion results that thoroughly pulverizes the soil to any required depth, and to a width of about 10 feet at each pass of the machine. It therefore not only plows but harrows, and so thoroughly pulverizes and aerates the soil that no weathering is needed. Two furrowing plows are attached, and planting can be done right behind the plow, thus effecting a great saving in the time usually required for preparing and planting.

Where there is any necessity of deep plowing, this implement can be driven even deeper than the steam plow, while at the same time it thoroughly pulverizes the soil instead of simply breaking it out in great lumps. Aside from its leaving the soil in good tilth as the

result of the one operation, with its consequent saving in time, the greatest advantage of this plow over the steam cable rig lies in its ability to work economically in small fields. The cable rig needs big, rectangular fields in which to operate economically. The plowing of small, irregular patches involves too great an expense. Oftentimes plantations have to be laid out anew on the introduction of steam plows. The Storey plow, on the contrary, notwithstanding its great power and bulk, is so easily managed that the size and shape of the

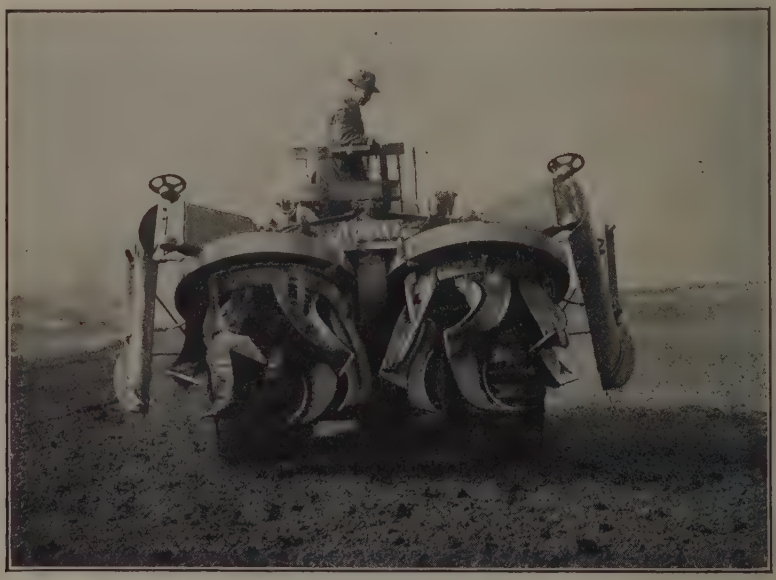

FIG. 8.—The Storey Plow, as manufactured by Fowler & Co. Showing the revolving plows lifted.

field makes but little difference in the cost of preparation. As a demonstration, Mr. Storey has backed this big machine into a little fenced-in house garden and has plowed every foot of it to a depth of 18 inches.

The Fowler Steam Plow people, of Leeds, England, were so impressed by demonstrations with this plow that they have arranged with Mr. Storey for manufacturing it, and it will soon be on the market. It promises much for the future of the cane industry and it will be even more important in the raising of sugar beets, where all the land has to be plowed and planted every year during a very

short period, and where a deep, mellow seed bed is even more important than for cane.

Another problem in soil preparation for cane planting is presented by those lands that have become set to Para grass (*Panicum barbinode*), Bermuda grass (*Cynodon Dactylon*), or any of the other perennial grasses with stems that take root and grow when covered with soil. It is very important that these be killed before the cane is planted. To do this effectively, they must be prepared during the dry season, and the first plowing must be shallow. If the grass is

FIG. 9.—The Storey Plow, as seen from the front. Plowing, pulverizing and opening planting furrows at one operation, at the rate of an acre per hour.

buried deeply, some of it will live even in the driest weather. The field should now be harrowed every ten days or two weeks, the soil being stirred, if possible, as deeply as it was plowed. A disc harrow and a tooth harrow, or, better still, the spring-tooth harrow to drag the grass to the surface, should be used alternately until such time as the grass is thoroughly dried out and killed. After this a second plowing can be given if necessary, going as deeply as the nature of the soil requires. Where steam-plow rigs are used for preparing such grass lands, it is of great importance that only the knifer and harrow be used, or at least that the turning plows be not put in until the grass has been thoroughly killed by knifing, cross knifing, and harrowing.

Complete directions for preparing lands can only be given in connection with a discussion of systems of planting. The above general considerations will apply to the red lands and most of the other types where no serious drainage problems are involved. The special preparation of low, wet lands will be considered under the planting system required in such cases.

CHAPTER IX

SYSTEMS OF CANE PLANTING

The method of planting adopted should depend on the nature and condition of the soil, and especially on its needs for drainage. Where cane is to be irrigated, it must be planted primarily with this purpose in view.

New-land Plantings.—As has been previously stated, new-land plantings, or *tumbas* as they are called in Spanish, are planted with no preparation except the felling and burning of the timber. Since the burning can only be done successfully in the dry season, new lands are usually planted in the spring or at the beginning of the rains. Formerly, holes were usually opened with the end of a sharpened pole or a crow bar and the seed pieces placed in them. At present, the planting is more often done with a pick. In either case, the hole is made slanting and not perpendicular so that the butt of the seed piece is covered by 3 or 4 inches while the top is at the surface. An ordinary custom is to plant in hills about 6 feet apart each way and to use two seed pieces, of three buds each, placed about 6 inches apart in the hill. This is insurance for securing a good stand; if one seed fails to grow, the other will make the stool. When seed is scarce, some planters take the risk of planting only one seed, and even of cutting this to two buds, but such light seeding is usually more expensive in the end, since, unless conditions are unusually favorable, much replanting will be required, and the cultivation of irregular, broken stands is always more expensive.

Little is attempted in the way of drainage, even on low, wet lands. Ditches are difficult and expensive to dig on lands filled with roots, stumps, and fallen logs, and they are usually attempted only to take the water away from the lowest spots which would otherwise be under water for considerable periods. The decaying tree roots keep the ground open and furnish a sort of under-drainage which prevents serious damage to the cane except in the lowest spots.

Subsequent cultivation consists merely in keeping the stumps cleared of sprouts with the machete, and the cutting out of vines and grass with the hoe. The number of such cleanings required varies

within wide limits, depending on the nature of the forest, the thoroughness of the burning, and the vigor and uniformity of the germination. Good stands close in quickly and require less expense for cleaning. Open woods, especially where they have been pastured, will give more trouble from grass and weeds than dense virgin forest. As a general rule, the heavier the seeding, the lighter the work of cleaning.

The Cuban System.—This name can properly be applied to the method so widely adopted in Cuba for the planting of old plowed lands. It consists in plowing the land level, simply driving around and around large lands. At the second plowing these lands are usually run in the opposite direction. From this habit we get the term cross plowing. After the land is plowed, cross-plowed, and harrowed, deep planting furrows are opened with big double mouldboard plows, at distances of from 5 to 6 feet. In making these furrows by animal power, it is usual first to mark off the rows with a big turning plow, running it twice in the same place so as to throw out a furrow in each direction, and then to pass a big, double mouldboard to deepen and clear the marking furrow. An equally good planting furrow can be made by one pass of a properly selected, big, double mouldboard sulky plow drawn by a small tractor. This is one place where tractor work is cheaper than the use of animals. The big steam rigs have two double mouldboards, attached to the so-called "cultivator" frame, which open up two good planting furrows at each pass over the fields. With some steam rigs, furrowing plows have been sent out on balanced frames like the turning plows but their work has never been satisfactory.

The seed material is dropped in the bottom of these furrows and is covered by means of hoes, small plows, or straddle-row disc cultivators. The quantity of seed and the method of seeding varies somewhat widely. At first planters are apt to follow the new-land tradition and plant in hills of two short seed pieces each. These hills may be spaced to row both ways so as to admit of cross cultivation, but more often they are spaced at distances of 3 to 4 feet in the row with two seeds placed side by side but as far apart as possible on the bottom of the furrow. This planting has nothing to recommend it, being simply a survival from new-land methods. It makes a wide row that cannot be cleaned with cultivators, the only possible way of getting rid of grass between the hills being by hand work with the hoe. The old familiar plantation eye hoe is the most expensive implement ever put into a cane field unless we except the spading fork, the use of which still lingers in some countries. Every effort should

FIG. 10.—Covering cane with a disc cultivator. Central Rosario, Cuba.

FIG. 11.—A cane planter improvised from a manure spreader. Central Rosario, Cuba.

be made to get rid of hand work in the cane fields. The Illinois or Iowa farmer who attempted to cultivate his corn fields with a hoe would be considered crazy. If he escaped being sent to a lunatic asylum he would certainly soon be bankrupt, and yet cane and corn growing are essentially alike, the only difference arising from the perennial nature of the cane plant. In order to reduce hand labor as much as possible, it is essential to plant in a narrow and practically continuous row, so that cultivators can be passed close to each plant on each side, and so that the row itself is occupied by cane instead of grass. In place of putting the two seed pieces side by side as described above, it is far better to place them one behind the other

FIG. 12.—The Elso Cane Planter, a Cuban invention. In the photograph the covering devices have been lifted so as to show the distribution of the seed and fertilizer.

to form a narrow row. The seed pieces can be placed end to end so as to form a continuous row from the first, or they may be spaced a little according to the richness of the land and the variety of cane being planted.

The habit of cutting the seed material into short pieces is another inheritance from the past. It comes to us from two sources. In many countries planting is mostly done during the crop and only the top joints of the cane are used for seed. These tops are necessarily short pieces. They are very good planting material but have poor value for the mill. In new-land planting as has been described above, even when body seed is used, it is necessary to cut it into short lengths

in order to get it covered with soil. In ordinary furrow planting on plowed lands no such necessity exists. When using body seed it is better to leave it full length as is done in Louisiana, only cutting it enough to straighten crooked canes. It has been abundantly proven that such long seed will give stronger sprouts than those coming from short pieces.

If planting in squares for cross cultivation, the use of long seed is obviously impossible. This method of check-row planting, as it would be called in the corn country, has, at first glance, some obvious advantages. In the long run, however, it seldom pays for the extra trouble of cross marking the field. It is true that by cross cultivation the greater part of the hand work can be avoided during the first year. The extra expense of cultivation, however, goes far to offset this advantage. Cultivating a field in two directions clearly costs twice as much as cultivating it only once, and the second cultivation must usually be given almost immediately, or the grass left in the narrow strip between the stools will get so big that cultivators will not kill it. In effect we have to cultivate the whole field to kill the grass on a strip 6 inches wide along the row. Cleaning this strip with the hoe would be little, if any, more expensive. The final objection to the system, however, is that cross cultivation cannot be continued with the ratoons. At least, to cross cultivate it would be necessary to burn the trash each year, and that is wholly inadvisable on most lands. From the fact that we always expect to cut a number of crops from each planting, sugar cane must always be planted with reference to the subsequent ratoon cultivation. This important matter will be fully discussed under another heading. Everything considered, it seems clear that the check-row method of corn planting does not lend itself to cane planting, but that the so-called "lister method" of planting in deep furrows and only cultivating in one direction, which is so widely followed for corn in Texas and the adjoining states of the southwestern United States, is exactly adapted to the "Cuban System" of cane planting. The same implements that are used for cultivating the young corn in the bottom of the "lister" furrows can be used for young cane, and in this way hoe work can be reduced to as small a minimum as is possible with the check-row system.

In this method of planting, the subsequent cultivation gradually fills the deep planting furrows, leaving the field level when the cane closes in and the crop is laid by. Ridging up the rows is neither necessary nor desirable. Any of the ordinary cultivating implements can be used successfully. Riding straddle-row corn cultivators of

any type are well adapted to cultivating the cane row, but as the rows are all spaced wider than with corn, it is necessary to supplement them with some other implement to finish the middles. The use of riding cultivators is not insisted upon, since most tropical labor is not accustomed to handling them, and because they are not adapted to ratoon cultivation. It is always important to reduce the cost of equipment to the lowest possible terms. The following simple outfit is suggested as being suitable and sufficient for either plant or ratoon fields.

First, and most important of all, the fourteen-tooth harrow cultivator. This implement does not carry straight teeth like a spike

FIG. 13.—The 14-tooth Harrow-cultivator. Very useful for maintaining a dust mulch during dry weather.

harrow, but very narrow cultivator blades not over an inch wide but with the tips bent forward as with the larger cultivator. This is the best implement for maintaining a dust mulch during dry weather. The success of fall or dry-weather plantings depends on the maintenance of such a mulch more than on any other one factor, and yet this is a point that is not understood by most cane planters. Because few weeds grow during dry weather, the young fields are allowed to crust and bake in the sun, cultivation being considered necessary only when the weeds and grass threaten to overtop the cane. Such neglected fields may live, for cane is a hardy plant, but they can never be expected to produce full yields and they will be so slow in closing that the total expense for cultivations and cleaning would be fully as great as would be necessary for passing the harrow cultivator every ten days or two weeks, thus keeping the ground in such good tilth that the cane would continue to grow even in the driest weather. A dust mulch, stirred occasionally to keep it from becoming compacted, is the most efficient known means of conserving soil moisture and promoting plant growth. This well-known fact applies as well

to cane as to any other cultivated crop. In fact, it is of greater importance with cane, since this crop needs to utilize a full twelve months for growth in order to give maximum yields.

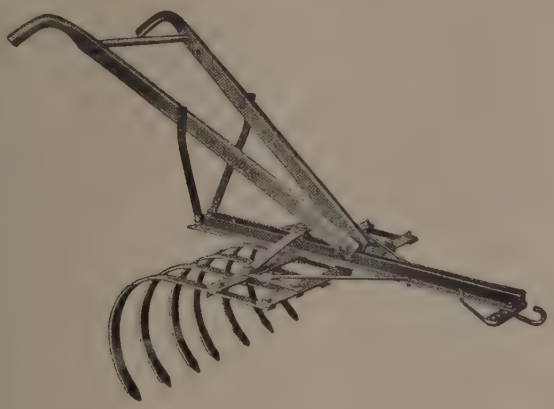

FIG. 14.—The Spring-tooth Cultivator. Another useful tool for maintaining a dust mulch.

Second, the three-shovel cultivator. This is an implement like the old-fashioned double shovel except that it carries three big 6- or 8-inch

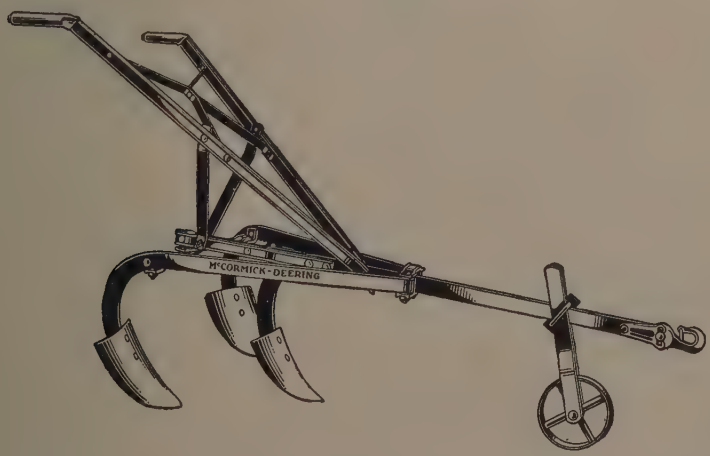

FIG. 15.—The Three Shovel Cultivator. One of the most useful implements in cane cultivation.

shovels in place of two. It is heavy and often requires two animals to pull it. It is for use during rainy weather or whenever grass and

weeds get too big to be killed by the harrow cultivator. Very often the best results are obtained by using first one and then the other of these implements. This is primarily a weed killer rather than a dust-mulch maker. The five-tooth cultivator is probably seen in the cane fields more often than any other implement. It is about half way between the two just described in use and effectiveness, but it does not fully take the place of either of them. There is no objection to including it in an outfit but there is no urgent necessity for it.

Third, a small 8-inch turning plow. This is an emergency implement and has no place in ordinary cultivation. During protracted rainy periods grass sometimes gets so high that it is impossible to kill it with cultivators and it becomes necessary to turn it under

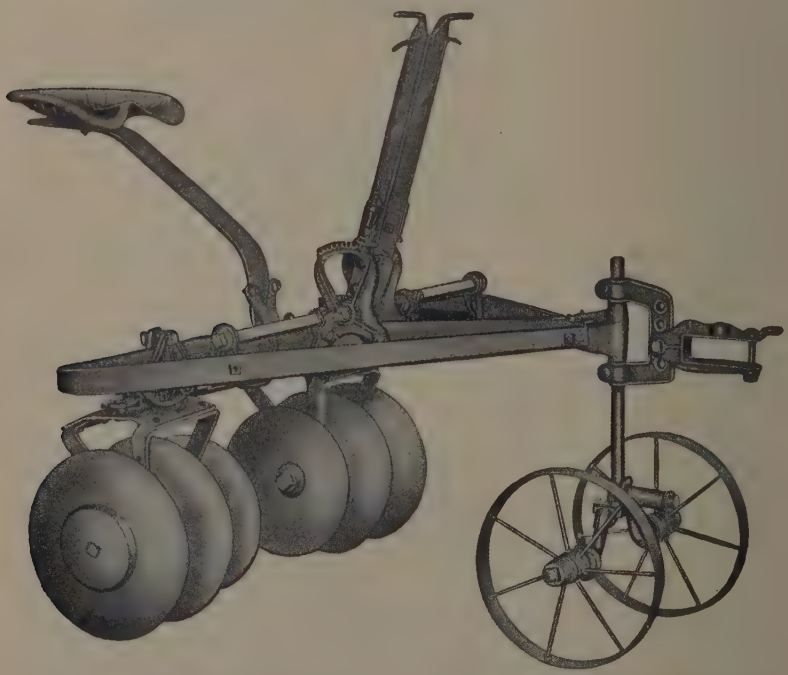

FIG. 16.—Reversible Disc Harrow. A useful tool in cane cultivation, especially for ratoon fields.

with these small plows. It is usually best to run them so as to bar-off the cane, throwing the dirt toward the middles. The old method of ridging up the cane with small plows should never be followed on lands suitable for planting by this Cuban system.

Fourth: The other implement that should be included in a cultivating outfit is a small, reversible disc harrow with only three discs in each gang. This is narrow enough to be run between the rows. It, too, is an emergency implement so far as plant cane is concerned, but it is invaluable when the weather turns suddenly dry after heavy rains and it is impossible to get the cultivators around fast enough to avoid crusting. This implement cuts through the crust and breaks it up into small pieces, making it much easier to restore a dust mulch. If the tooth cultivators are able to break through the crust at all they leave it in large fragments which are slow in working down if there are no more showers. This harrow, too, can be used as a straddle-row cultivator for young cane though it is not as good for this purpose as the regular riding cultivator with wheels. It is, moreover, one of the best implements for covering seed cane in the furrow. One of these disc harrows, drawn by two good mules, will do the work of twenty men with hoes in covering seed cane and if the ground has been properly prepared, they will do it equally well. In roughly prepared land it may be necessary to follow the disc harrow with a hoe gang to cover any spots that it has missed. It is, however, for its use in the ratoons, as will be described later, that this implement is particularly included.

Of course, this list might be almost endlessly extended, but with these four implements alone perfectly satisfactory cultivation can be maintained in both plant and ratoon fields.

These are all implements to be drawn by animals. Mules or horses are by far the best and most economical animals for cane cultivation, but in many parts of the cane country oxen are still generally employed. In some districts a long yoke is used so that the oxen straddle the row. By using a long hitch, the implement can be held on one side of the row. This does well for work close to the cane, and the middles can be finished while the cane is small, with the ordinary short yoke, driving between the rows. As the cane gets larger, however, this cannot be done since the ends of the yoke break down the cane badly. It is always best to train some of the best oxen to work singly. Used in this way, they do as good work as mules, but it is more expensive to work with oxen than with mules if the latter are properly handled.

More and more cane planters are attempting to do the work of cultivation with tractors. They are meeting with a certain amount of success, but tractor cultivation is still more or less in an experimental stage. None of the rigs on the market are fully adapted for this purpose. There seems little doubt, however, that these difficulties

FIG. 17.—The Centaur Tractor for cane cultivation.

FIG. 18.—A cane field cultivated with Centaur tractors. Central Stewart, Cuba.

FIG. 19.—Cultivating cane with narrow tread McCormick-Deering Tractor and disc harrow. Central Rosario, Cuba.

FIG. 20.—A field at Central Rosario, Cuba, planted and cultivated entirely with tractors. No animal-drawn implements have been used.

will soon be overcome and that we shall be able to cultivate the crop, as well as prepare the land, by gasoline power, or rather by alcohol power. It is an anomaly to buy gasoline for use in a cane plantation when so much material is available for the cheap manufacturing of motor alcohol.

The Porto Rican or Grand Bank System.—Lands that are low and flat, with a retentive subsoil, thus requiring great care to secure proper drainage, are poorly adapted to planting by the Cuban system as described under the last heading. This is being found out at heavy cost by many Cuban planters, now that they are facing the necessity of plowing and replanting great areas of low, black lands with a clay subsoil. When new and just cleaned of timber, these lands made splendid crops as long as the soil was kept open by the decaying tree roots, but they give out and require replanting much more quickly than the well-drained lands. Drainage is poorly understood by most Cuban cane planters since they learned their agricultural methods on the red lands where absolutely no drainage is required. These low, black soils are potentially the richest and most enduring of any in the island, but in only too many cases the attempt at replanting them is ending in absolute failure and they are being abandoned and turned into pastures.

In Porto Rico the handling of low, wet lands is much better understood than in Cuba. In fact, the industry there seems to have been first established on lands of this character. Unfortunately, the prevailing method of planting these lands calls for too much hand labor, and so is unduly expensive. Deep ditches are dug with the spade in each alternate middle, the dirt being piled between the two cane rows, thus forming ridges, the so-called "grand banks" with two rows of cane each. Of course, proper outlet ditches are provided. Subsequent cultivation is mostly done with the hoe. This provides thoroughly efficient local drainage, and good crops are obtained on lands so low and wet that they were originally "cat-tail" bogs; but the expense is prohibitive except with abundance of very cheap labor that has been accustomed to handling the ditching spade.

A modification of this system, by which the banks are made by back furrowing with the plow, and the dead furrows cleaned with a Martin grader or similar implement to form the ditches, is by far the most practical method for planting low lands. This can be done during the dry season on even the wettest lands, if suitable outlet ditches have been provided to lower the water table; and the expense will be only slightly greater than that of preparing the land flat for

the Cuban system of planting. Usually, the added expense will not be more than 5 or 10 per cent.

FIG. 21.—A field in wet land planted on the "semi-grand bank" system. Central America, Oriente, Cuba.

If the banks are made, say, 23 feet from center to center, there will be room for four rows on each bank, and this, for most locations, is preferable to a two-row bank.

FIG. 22.—Another view of larger cane in "semi-grand banks." Central Palma, Oriente, Cuba. Photograph by R. Menendez Ramos.

Making these banks when the land is being prepared with walking plows offers no difficulties whatever, the only added expense being two passes of the Martin grader to clean each ditch and finish the

banks, and even this can be made to take the place of part of the harrowing. The banks should be run in the direction of the greatest fall, so as to aid in clearing the ditches of water after rains. Guide stakes should be used at the center of each bank to make them straight and to secure proper spacing, Back-furrow against the stakes and continue until the bank is of the proper width, changing the stakes over to the next bank. Harrow with a two-gang disc harrow, running it first with the center in the dead furrow between the banks. This will help push out the dirt and build the banks still higher. A tooth harrow or a four-gang disc harrow tends to fill the dead furrows, and so should not be used. Do not cross plow. If a second plowing is needed, make it exactly like the first. Two plowings will throw up a good, serviceable, well-drained bank which will never suffer from water if the main outlet ditches are kept open. Now complete the banks by a round of the Martin grader in each ditch and a light harrowing on top of the bank. Do not open deep planting furrows. They are not needed. The whole object is to get the cane up out of a too-wet subsoil. The rows may be marked with a small single shovel plow or by stretching a line. In either case it is best to use short seed, and to put it in with a pick, as is done in new-land planting. The cane can be given flat cultivation on top of the banks, as in the Cuban system. The same implements are available.

Very good banks can also be thrown up with either large or small tractors, but some ingenuity is required to route the tractor so as to get the desired results. It is best to lay off the field with a row of small stakes at each end, marking the center of each bank. Make the range stakes as long as half the width of the bank, so that, in the centers of the fields, measuring up two lengths of the stake will give the center of the next bank. Provide enough range stakes for marking the center of two banks. Set them to mark banks 1 and 4, counting from the right-hand side of the field. Start with the tractor on the inside of bank 1, running close to the stakes and throwing the dirt toward them, as each stake is passed setting it over to its place in bank 2. At the end of the field, pass banks 2 and 3 and turn up bank 4, moving these stakes forward to mark bank 5. Run enough rounds in this way to complete the inside half of bank 1 and the outside half of bank 4. The number of rounds required will, of course, depend on the size of the outfit being used. After the last round on bank 4, turn back down the middle of bank 2, and from there to bank 5, and continue in this way to the end of the field, always leaving two banks between the ones on which the tractor is working. This requires nothing but left-hand turns to be made.

Many plow gangs are not adapted for making right-hand turns. Working in this way, the outside halves of banks 1, 2, and 3 will be left unplowed. There will be three similar half banks left on the farther side of the field. Both sets can be finished by making a few long rounds with the tractor. The harrowing and cleaning out of the ditches between the banks are done in the same manner as when the banks are made with walking plows.

The cable steam plows have no rigs [1] by which the land can be thrown into banks. Where these are used it will be necessary to prepare the land flat and then throw it into banks by opening ditches with the grader. This answers fairly well, but it has the disadvantage that the center of the bank tends to be hollow instead of rounded. This difficulty could be obviated by making narrow two-row banks. The Storey plow has an attachment by which a 10-foot two-row bank can be made at each pass of the implement in place of the usual deep planting furrows.

This method of planting is not in extensive use outside of the low lands of Porto Rico, but enough has been done in eastern Cuba to demonstrate its great benefit and entire practicability. It is the only way known by which to get fully satisfactory results, at reasonable cost, under tropical conditions, on low lands with a retentive subsoil. Planted in this way, these lands will give very cheap cane, since they will ratoon strongly for many years if care is used to keep the drainage open, and they will usually require no fertilizer, this saving much more than offsetting the slightly greater cost of planting.

In planting low, wet lands the question of varieties of cane should be very carefully considered. Some kinds are much better adapted than others to such conditions.

The Louisiana System.—In Louisiana the planting of low lands which need drainage is handled somewhat differently. Here the problem is complicated by the comparatively short growing season, and the necessity of getting the cold soil warmed up as quickly as possible in the spring to start an early growth. This is accomplished by planting on what we may call one-row banks. The field, when prepared, looks much as if it were intended for planting on the Cuban system, but the seed material is placed in the ridges and not in the bottom of the furrows. The rows of fall plant cane and ratoons are off-barred early in the spring to let the sun in as near the roots as possible to warm them up, but in the subsequent cultivation the dirt is always worked toward the cane so as to keep the furrows open for

[1] There is a rig by which land could be thrown into 2 row banks, but none have been seen in the West Indies.

drainage. Quarter drains, as they are called, are provided at convenient intervals, crossing the rows so as to take off the water from these drainage furrows. These drains have to be cleaned after each cultivation. As a rule, only one crop of ratoons is taken, and for this crop it is necessary to burn the trash; otherwise it would clog the furrows and quarter drains since there is no available space in which it can be piled, such as is afforded by the middles of the broader banks of the Porto Rican system.

This method of planting does not serve well for tropical conditions, where it is usual to take a succession of ratoon crops and where the constant burning of the fields is so very unwise. Besides, in most tropical cane countries the crop suffers from drought for half the year, even on the wettest lands, and the narrow, sharp ridges of the Louisiana system would dry out unduly. We need to get the roots down as deep as possible to protect them from the sun, and not to expose them to its warmth.

The Hawaiian System.—In irrigated cane fields it was formerly the custom to run the rows with the slope of the land, and to turn in the water from a ditch at the upper end, letting it run down the row for considerable distances. This method is objectionable for several reasons. If too great a head of water is used, especially if there is much fall to the land, the row will be badly washed and cut by the water. If the head is too small, much time will be lost waiting for the water to run through to the bottom of the row. There is always an uneven distribution of the water, some parts of the field getting much more than others.

In Hawaii, these difficulties have long been obviated by running the rows on the grade lines and bringing the water furrows down across the rows at rather frequent intervals. The rows are planted in deep furrows as in the Cuban system, and great care is used always to maintain the ridges or banks between the rows in order to hold the water. On hill sides the rows follow the contour lines without regard to direction, as is done so often on hill lands in the southern United States. Such fields, with rows circling the hills, look very awkward to one accustomed to absolutely straight rows, but in reality they present few practical difficulties. In irrigating, the water is brought in a supply ditch along the upper side of the field, and it is turned in to one after another of the water furrows that cross the cane rows. These furrows are usually placed from 30 to 60 feet apart, according to the nature of the soil. A man is required for each water furrow, and only a moderate head can be used in each. The furrow is banked with the hoe in front of each cane row, and

the water is turned in, first on one side and then on the other, until the short length of furrow is filled to the desired depth. The end of the row is now blocked by a stroke of the hoe, to hold the water in the furrow, while the current is turned into the next row. Working carefully in this way, a good irrigator will cover about an acre a day and secure a very even distribution of the water, even on quite hilly land: and all the water is held in these short, deep planting furrow sections so that it soaks in with no loss. A limited quantity of water will go much farther when used in this way than by the old method, but the labor cost is somewhat greater.

This is unquestionably the best method of applying water to cane fields that has so far come into general use, and it has been adopted in Porto Rico and other countries where cane is planted under irrigation. The Hawaiians, however, are not fully satisfied with it and are making continued efforts to devise better methods for utilizing a limited water supply. They are even experimenting on a large scale with overhead sprinkler systems, such as are in use in some sections for high-priced truck crops. The overhead system is unquestionably very economical of both water and labor, but its first cost is so excessive that it seems doubtful if it can ever come into general use for a large-scale crop like cane.[2]

One great advantage of the Hawaiian system of irrigation is that there is much less danger of over-watering than by the old method. Very serious damage is often done by over-irrigation, not only in water-logging and injuring the crop, but in permanently injuring the soil by causing an accumulation of salts in the surface layers.

In most regions where the climate is dry enough to require irrigation, there is a greater or less accumulation of soluble salts in the soil. If such lands are repeatedly flooded, without proper precautions to secure prompt drainage, the water slowly evaporates from the surface where it leaves the salts dissolved from the subsoil. Many valuable areas of cane land have been ruined by the unwise use of too much water for irrigation.

The cultivation of these irrigated fields presents some special problems, since it is not permissible gradually to break down the banks and fill the planting furrows as is done in the Cuban system. A field planted under the latter system looks at first like one intended for irrigation. The banks between the rows must be maintained so as to hold the water, not only for the plant cane, but for subsequent ratoon crops. This has seemed so difficult with the ordinary shovel cultivators, which constantly tend to tear down the banks, that in

[2] Its use seems to be gradually extending in Hawaii.

only too many instances little implement cultivation is attempted, the fields being cleaned with the hoe with perhaps one furrow of a small turning plow turned toward the cane on either side in the bottom of the furrow just before the cane closes. This is unfortunate since irrigated fields really require more cultivation than non-irrigated ones, to prevent the soil from becoming unduly compacted from the frequent applications of water. It should be an invariable rule to stir the surface with some implement as soon as the land is dry enough after each irrigation. This not only secures the better aeration of the soil, with consequent better thrift of the plants, but, by breaking the surface and forming a dust mulch, it checks evaporation and very materially extends the time before another irrigation is needed. It is safe to say that on most soils from a fourth to a third less water will be required when irrigations are thus alternated with cultivations. This cultivation will present no great difficulty once the proper implements have been selected. While the cane is small, the row may be cultivated by the lister corn cultivators, working in the bottom of the furrow as has been suggested under the Cuban system.

After the cane is too tall to be straddled by these implements, the single shovel "Georgia stock," with a short narrow shovel and an 8- to 12-inch "heel sweep," may be run on either side of the cane in the bottom of the furrow. This will throw a little dirt to the cane but will not seriously injure the banks. The banks will not need as frequent cultivation as the bottom of the furrow. They can be kept clear of grass and weeds by using alternately the small reversible disc harrow with the gangs set to throw to the center, and some scraping implement like a Planet Jr. cultivator with hilling-up wings, but with the wings reversed to throw to the center, and with the cultivator shovels removed. A home-made contrivance along these lines, made with larger wings, will do still better work. Both of these implements tend to pull the dirt toward the center and so build up the banks rather than tear them down. The disc harrow loosens the surface, and the scraper pulls out any grass not killed by the discs.

After the crop is cut, where fields are to be ratooned, the trash should be at once lined in alternate middles. One side of each row can then be off-barred with a 10-inch turning plow, and the cleared bank can be reformed with the dirt thrown out by the plow, the disc harrow and scraper being used to pull it to the center. This gives a free pass for the water down one side of each row. It will soak under the trash on the other side, which will act as an efficient

mulch to prevent evaporation. With the quantity of trash left from an irrigated crop, this mulched middle will be so well filled that it will require no further attention of any kind. All the cultivation next to the cane must be done with the Georgia stock and heel sweep, since straddle-row cultivators cannot be used in ratoon fields where the trash is not burned.

Some one of these four methods of planting will be found applicable, perhaps with some slight modifications, for the planting of any kind of plowed land that is likely to be put in cane. In fact, the choice is limited to three methods, since the Louisiana system is very narrowly limited in its applicability. It is very probable that even in Louisiana the Porto Rican system would give better results, since it lends itself so much better to the needs of ratoon cultivation, and does not require the annual burning of the trash. With the rapid shift to the POJ varieties now (1926) taking place in Louisiana, it is quite certain that more than one ratoon crop will be taken, and this will suggest even more strongly the possible advantages of a change in the system of planting.

In connection with systems of planting, a word should be said regarding the use of mechanical planters. They are being experimented with extensively and successfully in various countries but more particularly in Hawaii. Since they are still in an experimental stage an extended discussion of them is hardly in place at this time, but there can be little question that in the near future cane seed will usually be placed in the row by mechanical means. The planters so far in use are designed for short seed and deep furrows, but there is nothing to prevent the devising of means for handling long seed, or for planting on the grand-bank system.

There is no possible justification for the method, which still lingers in some countries, of digging holes by hand in plowed land and placing the cane seed in them. This is simply an inheritance from the old forest-land methods. These holes have no possible advantage over a deep furrow, and they are much more expensive. Then, too, cane planted in holes is more expensive to cultivate, since the space between the holes has to be cleaned with the hoe. Where land is so rocky that it cannot be plowed, it is often possible to plant it by digging holes, but this will also necessitate hoe cultivation, and the expense is so great that such plantings are seldom justified except perhaps to square out some small corner of a field.

Ratoon Cultivation.—This is one of the most important matters that can engage the attention of the cane planter. In this day of close competition and low prices, only those cane-growing districts and

those planters can survive that are able to produce abundant and cheap crops of ratoons. A field of plant cane that pays for itself with its first crop may be considered a very good investment, since, with proper management, the subsequent ratoon crops will show a good profit even if sugar prices continue low. To make a profit, however, good tonnages must be maintained. Land rent and other overhead expenses will be the same for a crop of 10 tons per acre as for one of 20 tons. Cultivation costs are likely to be even higher for the small crop than for the large one, since the cane will not close in as quickly. Then too, a properly handled field will last in good production for many more crops than one that is poorly cultivated, thus avoiding frequent heavy expenses for replanting. Outside of Java and other countries with a very cheap labor supply, it is doubtful if the cane industry can continue to exist in any country that only takes one or two crops from each planting, unless it is aided by protective duties or some form of government bounty. On the other hand, there is much reason to believe that in those countries that still practice frequent replantings, a considerably greater number of profitable ratoon crops could be taken by some changes in varieties and methods of cultivation.

The fact is that the custom of making frequent replantings has come down to us from the time when the Otaheite cane was the only variety in general cultivation. This kind has a weak root system and it ratoons very badly on old lands. In many cases it is impossible to get even one satisfactory ratoon crop. With the great number of really very good cane varieties now available, there is no excuse for continuing to plant one in any locality when it will not give a considerable number of profitable ratoon crops.[3] The great economic importance of ratoon crops will be better appreciated when it is remembered that under good average conditions it costs twice as much or more to produce a ton of plant cane.

With cane planted on timber lands, cultivation of both plant and ratoons is reduced to its lowest terms. After the cane is cut the trash is allowed to lie as a mulch over the entire field. But little grass will grow, and such sprouts and vines as appear are cleared by two or three passes with hoe or machete. Where the land is well drained, such simple measures result in satisfactory ratoon crops for many years. Even when failing crops give notice that a change in method is necessary, real ratoon cultivation is difficult on account of

[3] The only exception to this general statement would be the case of those countries where serious cane diseases, like sereh, Fiji, or leaf scald, prevent the taking of profitable ratoon crops.

the hardwood stumps and roots which still fill the land. After the softwood stumps have rotted it is possible to clear the trash from alternate middles and give a rough cultivation among the remaining stumps with small plows and three-shovel cultivators with break-pin attachments; but in many cases it is better to demolish the field, dig out the stumps, and plant it over again properly.

On plowed lands the first step in ratoon cultivation should always be to clear the trash from alternate middles and pile it as a double mulch between the other two rows. This can be done by hand with rakes or forks, but it is cheaper and quicker to use an ordinary sulky hay rake driven across the rows. There is just time for the driver to dump the rake on each alternate middle, thus clearing the field quite satisfactorily. The use of a side-delivery rake at once suggests itself, but so far these have not been satisfactory. Those on the market being made for use in hay fields are too broad for this work, and they are not made strong enough for work in cane stubble.[4] There is the further disadvantage that they must be driven around the field, a method which does not answer well for clearing trash from alternate rows.

This work should be done as soon as the cane has started enough to permit the rows to be seen, usually in a week or ten days after cutting. It is a great mistake to delay it too long, but the rake can be used successfully even when the cane is 2 or 3 feet high. In good cane the double thickness of trash piled in the mulched middles will be sufficient to keep down all weeds and grass, so that half of the field will require no further attention. Workmen should not be allowed to stir up this mulch with the hoe after it is once matted down. Let it lie undisturbed, pulling out by hand any weeds that chance to come through it. Besides saving the trash which gradually rots on the surface and is ultimately incorporated in the soil, this method reduces the area, and consequently the costs, of ratoon cultivation, by just one-half, which is a consideration of vital importance in the production of cheap cane. This heavy mulch, too, is an important factor in checking evaporation and conserving soil moisture, always a matter of great importance since cane is harvested during the dry season. There is the further great advantage that half the field is shaded from the sun, thus providing favorable conditions for those biological activities on which the fertility of the soil so greatly depends. Under tropical conditions long-continued clean cultivation should be avoided whenever possible. The sun is so powerful that

[4] A specially made rake of this type for removing cane trash is now on the market and is giving satisfactory results.

it tends to burn out the humus and rapidly deplete fertility. There is nothing more necessary than tillage for promoting crop growth, but it must be used with caution and intelligence or it may become a serious evil. In a ratoon cane field where one side of each row has the shade and protection of a heavy mulch, while the other side gets the advantages of frequent tillage while the cane is small, we have really ideal conditions for promoting growth.

In old fields that have become invaded by pernicious grasses, especially when the stand of cane is poor, it is sometimes best, after plowing and cultivating the cleared middle, to transfer the trash to it, thus allowing for the plowing of both middles. This, of course,

FIG. 23.—A field of ratoon cane with trash lined in alternate middles and the cleared middles off-barred and cultivated. Central America, Oriente, Cuba. May, 1928. Photograph by J. Menendez Ramos.

is an added expense, and it is only necessary when making up for previous neglect. There is seldom any occasion for this double working in fields that are continuously properly handled.

In the second year the trash should naturally be lined in the middle that received cultivation the first year. On breaking up the middle that has had the protection of the heavy mulch, its advantages will be at once apparent from the mellow texture and the quantity of fine half-rotted trash that is left to be plowed into the soil.

At various times, considerable interest has been shown in developing an implement by which the coating of trash left on the field after harvesting could be cut up into short lengths so as to admit of immediately plowing it under. Implements for the purpose, which

are more or less successful, are now on the market. It is doubtful if they have a place in ratoon cultivation, except perhaps in the reconditioning of half-abandoned fields. Aside from the bad effect of plowing under so great a mass of crude fibrous material during dry weather, this blanket of trash, if left on the surface and properly handled, is too valuable, not only in preserving soil moisture and soil fertility but in saving almost half the cost of ratoon cultivation. By the second year it will be in much better condition for incorporating in the soil.

As soon as possible after the field is raked, the cleared middles should be barred off with a 10-inch plow run as close as possible to

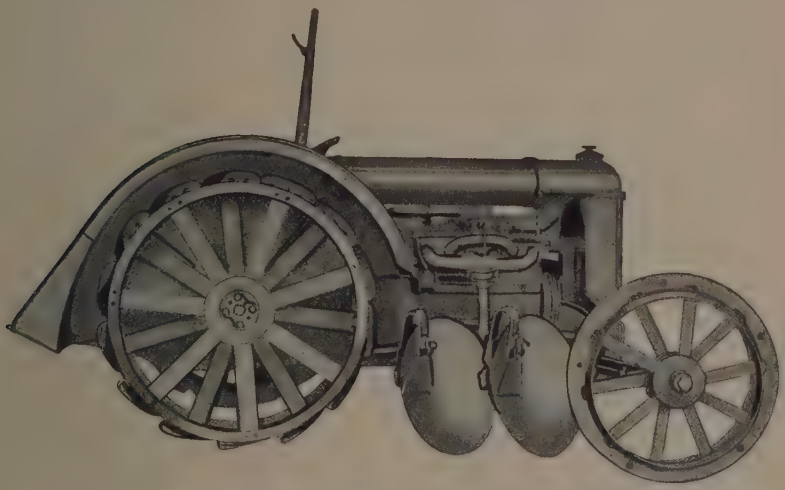

FIG. 24.—The Oliver Side Disc Plow for Fordson tractors. One of the most practical machines for off-barring ratoon cane.

the cane row. If part of the larger stools are torn away, so much the better. When first uncovered from their coating of trash, even the hardest soils can usually be plowed, but if they are allowed to stand for a few days and bake in the sun it will be impossible for the plow to enter them.

If fertilizer is to be used, now is the time to apply it. The two-horse Avery fertilizer distributer, with two delivery tubes, driven down the plowed middle will make the application to both rows at once, or it can be scattered by hand in the bottom of the furrows.

The small, three-disc gang, reversible harrow is much the best implement to use for cutting up the furrow slices and covering the

fertilizer. It should be set to throw out and should be passed a sufficient number of times to cut up and level off the plow furrows. Subsequent cultivations can be given with the same implement or with the three-shovel or fourteen-tooth cultivator, whichever is indicated by the condition of the soil. Handled in this way, really effective ratoon cultivation will cost no more than the proverbial "three cleanings" with the hoe. In many cases where it has been possible to obtain comparative figures, yields have been increased fully 50 per cent over the old hoe method. Not only this, but the number of laborers required is so small as compared with hoe work, that this method obviates the chief objection to cleaning the ratoon fields during the crop. As the class of men capable of cultivating with implements are seldom willing to cut cane, there is no interference with the harvest.

This method of lining the trash in alternate middles is not new. It has long been the prevailing custom in Porto Rico and some other parts of the West Indies. It has many obvious advantages over burning the trash as is done in Louisiana and Hawaii, or leaving it over the entire surface as is still the prevailing custom in Cuba. As outlined above, it applies more particularly to fields planted for level culture under the Cuban system. It is used equally successfully in Porto Rico for irrigated fields planted on the Hawaiian system. Cultivation and irrigation are all done in the one cleared middle. The method also applies equally to fields planted on banks as in the modified Porto Rican system, the only difference being that the trash must always occupy the same two middles on the sides of the banks, leaving the center middle and the ditch middle open for cultivation. Care must always be taken to "lay by" the ditch middle with a pass of the double mouldboard in order to keep it open for drainage. This method can hardly be applied with the Louisiana method of planting, on account of difficulty with drainage.

With the more general planting of the hardy modern canes, carrying some portion of the deep, strong-rooting *Saccharum sinense* and *S. spontaneum* blood, the future of the cane industry will be more and more in the ratoon fields. Handled by this effective but inexpensive method, there is no reason why, with a proper selection of varieties, an average of eight or ten crops should not be secured from each planting on all reasonably good lands, and in very many cases the number will be considerably greater. People who are plowing up and replanting their fields every third or fourth year should carefully re-examine the reason for this method. In many cases it will be found to be little more than the tradition coming down from

the time when they only planted the Otaheite cane, a kind that always ratoons poorly.

Drainage.—This vitally important matter is so largely a local question that a general discussion of it is difficult. There is no subject that requires greater experience and intelligence on the part of field managers. The amount and character of the drainage required depends naturally on the topography but even more on the nature of the soil and more especially of the subsoil. As a rule, in hilly lands, the only ditching required will be the cleaning out of the natural runways to prevent local stoppages, and sometimes the providing of cut-off ditches at the upper side of fields to divert water coming down from above and prevent damage from washing. In some cases, however, wet, seepy spots will be found even on steep hillsides. These are caused by impervious layers in the subsoil which outcrop at these spots and bring the deeper subsoil water to the surface. Such seepy spots are often hard to handle. Sometimes they can be cured by a deep cut-off ditch which intercepts this underground water and carries it away. More often they are best handled by local banking, as described under the Porto Rican method of planting, thus giving surface drainage.

Even lands that are practically level, like the Cuban red lands and many parts of the alluvial lands of south Porto Rico, will require little or no drainage, provided that the subsoil is sufficiently open and permeable to allow for the prompt sinking of the water after rains. Ditching on such lands is not only unnecessary but is a positive disadvantage. Over-zealous field men with limited experience often make the mistake of digging expensive ditches where they do more harm than good.

On level lands with a close, impermeable subsoil, proper drainage becomes a question of overwhelming importance. When properly handled, such lands are among the very best for sugar cane, but in only too many cases improper and insufficient drainage is a seriously limiting factor in production. In handling such a property the question of primary importance is to secure a sufficient outlet to carry off storm water promptly and prevent it from accumulating and covering the land. If natural water courses occur they should be cleaned out and deepened if necessary. If they do not occur they must be made. To locate the main outlet ditch and its principal branches will often require a topographical survey to establish the grade lines and determine the available fall. This, as well as the size of the area to be drained and the probable rainfall, must be taken into account in determining the size of the ditches that will

be required. The area to be considered must be the entire drainage basin from which water will flow to this outlet and not the particular property under cultivation. Where large areas are involved, a competent drainage engineer should be employed to lay out the main ditch system and determine its capacity. In making ditches for drainage or for any other purpose, hand labor should be avoided wherever possible. The pick and shovel, like the hoe, are very expensive implements. Dredges or steam shovels should be used for the main canals, and slip scrapers and road graders for the laterals. Fields should always be laid out in such a way that grading up the roadways and turn rows, while affording better transportation, will at the same time provide the lateral drainage ditches. Lateral ditches usually do not require to be deep but they do need to be kept open. This can be cheaply accomplished by occasionally cleaning them with a road grader.

After main ditches and laterals are all prepared, it is still necessary on lands of this character to throw the surface into banks before planting, as has been described under the Porto Rican method, in order to secure efficient local surface drainage. No amount of big ditches will do this on really heavy lands. The ditches are needed as outlets, but quickly to clear the surface of water we need the artificial ridges of the banks.

The usual excuse for failing to provide proper drainage is that it is too expensive. Ditches are expensive if dug by hand with pick and shovel. Even so, the lack of them is likely to be much more expensive, in loss of yields on what are really the best cane lands. As a matter of fact, there are comparative few tracts so level that the rains have failed to cut natural drainage channels through them. These very flat lands will require a considerable outlay for topographical surveys and for cutting outlet canals, as discussed in a previous paragraph. Such lands should never be planted until the initial outlay can be provided for. In the great majority of cases, even on lands that appear flat to the eye, natural drainage channels will be found that at small expense can be so cleared out as to serve as outlets. Where this is the case, grading up the roads between the fields will provide all the outlets needed for clearing the water furrows between the banks. This small expense will be largely repaid by the improvement in transportation afforded. The broad, shallow type of ditch made by a grader can be crossed without difficulty at any time in dry weather by carts and wagons, while a perpendicular-sided hand-made ditch is always a serious obstacle in hauling. As has been previously shown, it costs very little more to plow the land

into banks than it does to plow it flat. In most cases, therefore, the supposed excessive cost of drainage does not exist. If the work is properly done the added expense is very small and the added returns in greater yields and prolonged life of the fields are very great. No one having lands that require it can possibly afford to neglect this most important and really inexpensive work.

On irrigated lands careful attention to drainage is particularly needed. In only too many cases no provision is made for clearing the water promptly from low spots where the surplus irrigation water accumulates. If the subsoil is sufficiently open to admit of percolation, such wet spots usually cause no serious injury, but with a tight, impervious subsoil the water must lie until evaporated by the sun. This, of course, leaves all soluble salts behind, with the result that a salt spot is gradually formed where cane will no longer grow. Untold thousands of acres of the best irrigated cane lands have been ruined in this way by careless excess in irrigation, with no proper provision for prompt drainage of the low spots. Such injury, while easy to cause, is difficult to cure. Deeply laid tile drains will finally cure such spots in most cases, but the cost is excessive. Such salt spots are usually treated by the digging of deep canals through them to lower the water table permanently, and then by diking in and heavily flooding the salt areas, thus reversing the process that formed them, by forcing the dissolved salts back into the subsoil and finally out through these deep canals. The success of such reclamation projects depends on the care and thoroughness with which they are carried out, but more particularly on the degree of impermeability of the subsoil. With very impermeable subsoils the work of reclamation is slow and difficult.

When the sugar-cane industry finally comes to realize that the sugar is, after all, made in the field and that proper field expenditures are as necessary and legitimate as improvements in the factory, then doubtless many low-lying areas will be under-drained with tile, for this is without question the best and final solution for the handling of most such lands. At present it is useless even to ask for such capital expenditure in the fields, especially where really effective substitutes are so cheaply available.

Irrigation.—When we mention irrigation for sugar cane we are usually thinking of some parts of Hawaii, the south coast of Porto Rico, the sugar lands of Peru, or some other region where the rainfall is so scanty that crops are almost totally dependent on artificial watering. Such dry climates often have very fertile soils since the elements of fertility are not being constantly washed and leached

away by the rains. The world's highest sugar yields are obtained where crop production would be impossible without irrigation. In such districts the industry absolutely depends on the development and proper utilization of the water supply. Future developments are limited, not by the area of available lands, but by the possible water supply. Where the three factors of a dry, warm climate, fertile soils, and abundant water supply are all combined with accessibility to ocean transportation, conditions are admirable for the cane-sugar industry. Such favored localities need have small fear of successful competition from other sugar crops or from less favored localities. Unfortunately, such ideal conditions are seldom found. The bulk of the world's sugar must still be made in the face of many difficulties. Among the worst of these are the periodic droughts that are so likely to cut short yields in all districts that are dependent on the natural rainfall for producing crops.

In many cases it would be possible at reasonable expense to provide water for partial or supplementary irrigation to act as an insurance against drought and to prolong the growing season. Oftentimes only one or two irrigations in the course of the year would very materially increase yields. In all regions with a pronounced wet and dry season, where the cane is harvested during dry weather, if it were possible to turn on water as soon as the field was cut, or rather as soon as the trash could be lined and alternate middles off-barred, the ratoons would at once start into vigorous growth. By alternating irrigations with cultivations, the early-cut fields would be closed in by the time the rains began. It is strange that the obvious advantages of such supplementary irrigation have been so completely overlooked. It seems certain that it will be more utilized in the future. Where water is available for gravity irrigation, it should certainly be utilized. Irrigation from pumps is usually more expensive, but with modern crude-oil engines of the Diesel type, or where electricity is available, the cost of pumping is by no means great enough to be prohibitive. In thinking of irrigation costs, people always think of the costs where practically all the water must be applied artificially and where it will take fifteen or twenty irrigations to produce a crop. The kind of supplemental irrigation here being considered would only involve from one to a maximum of four or five irrigations. If applied with judgment, these might easily increase yields by 40 or 50 per cent, and would at the same time tend to prolong the productive life of the fields. It is the strain of a prolonged drought that usually determines the going out of a cane field.

Irrigation by gravity may be obtained from running streams, or

from storage reservoirs which impound and hold storm water for use during the dry season. Such water is always cheaper than pump water unless ditches are unduly long and difficult to maintain. Running streams, of course, are preferable as sources of irrigation, but they are by no means always available. Storage reservoirs can seldom be depended on in dry countries that require constant irrigation. Their capacity would have to be too great and the chances for filling them too infrequent.[5] In regions of normal rainfall, however, it is almost always possible to find dry gulches that can be dammed at comparatively small expense and will fill during the rains and hold water enough for the few irrigations required. Of course, in making artificial reservoirs, water pipes with gate valves should be placed under the dam at the proper level for drawing off the water into the supply ditch for the fields. If earth dams are used, spillways, of sufficient capacity to prevent water from ever running over the dam, must always be provided. If the water should run over the dam, the earth fill would be cut out in a very short time. Such reservoirs are only available where there are impervious subsoils.

Water for pumping is usually secured from wells but sometimes from ponds or lakes. Pumping from rivers should usually be considered only as a temporary makeshift until such time as ditch lines can be provided for taking out the water and distributing it by gravity. Pumping from ponds usually necessitates a long pipe line to force the water up to the higher levels from which it can be distributed by gravity. If underground water for heavy pumping is available at a reasonable depth, the cost of such a pipe line may be greater than that of putting down wells. Before heavy expenses for irrigation are undertaken, the possibilities of the underground water supply should be thoroughly studied. Wells, of course, are of two general types: open, dug wells; and bored, or so-called artesian wells. The latter term should be reserved for those bored wells from which the water flows naturally without the need of pumping, but it is often applied to bored wells in general. The type of well to adopt will depend largely on the depth at which a good water supply is found. Where bored wells are used it is a common practice to sink a number of them near together so that they may be connected by suction lines and all be pumped from a central station. A common installation is eight wells in a line, 50 to 100 feet apart, with the pump house in the middle of the line. This, of course, involves a trench deep enough to get the suction pipe down within suction distance of the water.

[5] This statement does not apply when reservoirs are fed by mountain streams.

The kind of pumps to use, the gates for controlling and dividing the flow, and the weirs for measuring it all fall within the province of engineering rather than of agriculture, and a discussion of them will not be attempted here. The engineer must bring the water to the highest part of the field, and there he turns it over to the field man.

The usual method for handling and distributing the water in the field has been discussed under the Hawaiian method of planting. This method of planting the rows on the grade lines and carrying the water furrows across them at frequent intervals gives decidedly better results than the old plan of running the rows with the slope and allowing the water to follow down for considerable distances. A given quantity of water goes much farther and a more uniform and better controlled distribution is secured. The only objection to this method seems to be the amount of labor required. Under average conditions an irrigator will not cover more than about an acre a day, and this constitutes a heavy expense when frequent irrigations are required.

In some countries cane is irrigated by putting up borders and flooding entire sections of the field, as is done with alfalfa. This requires less labor but a larger water suply, and there is always the grave danger of over-irrigating and water-logging the land. Cane is injured very seriously by too much water. Countries where this method is used seldom secure maximum yields.

With any of these methods of distribution, a matter of great practical importance is to know when to stop irrigation in order to ripen the cane properly for harvesting. This requires judgment and experience, for the length of time for which water may be withheld with safety will depend on the temperature, the nature of the soil, and the variety of the cane. Under some conditions the cane will begin to dry out and suffer even before it is properly ripened. If water is withheld too long on such fields, the ratoon will suffer seriously. When cane really begins to dry up, proper ripening ceases, and no further improvement in sucrose and purity will be noted. In fact, dried-up fields give low purities, and it is much better to cut down the amount of irrigation water but not to withdraw it entirely until just before cutting. In most cases, however, such precautions are not needed. The temptation is to hold on to the irrigations too long in order to increase tonnage, with resultant heavy losses in the mill from grinding immature cane. This and the allowing of too much time to elapse between cutting and grinding are usually the two greatest sources of avoidable losses in the cane-sugar industry.

The change of color of the cane which occurs on ripening is usually a fairly safe guide as to time of cutting, but frequent hand-mill samples should always be taken to make sure that the cane has really reached its maximum sucrose content. It is clearly a great blunder to cut cane at 14 per cent sucrose if a few days later that same cane would give 16 per cent, and yet this is an error that is constantly being made even on properties that are otherwise well managed. When the grower is dependent on rainfall he must take what comes, and the condition of his cane at cutting is not always within his control. One of the great advantages of irrigated cane is that maturity is absolutely under control. There is small excuse for grinding cane that is not at its maximum condition of sweetness.

Fertilizers.—The use of commercial fertilizers is so largely a local question that it is difficult to give a general discussion that will not be more or less misleading. No question is of greater importance, for on practically all of the older cane lands applications of fertilizing material are necessary to maintain profitable yields. Field managers should always make it their first business to study and understand thoroughly the fertilizer needs of their different types of soil. Heavy losses are constantly occurring, both from the use of improper fertilizers and from their improper application. Often it is by no means easy to determine what is the proper usage. Chemical analyses of the soil are usually helpful if properly made and interpreted, but they should always be checked up by plot experiments. These, too, should be repeated again and again, for nothing is easier than to be led astray by unsuspected local differences in the soil of the plots or by the effect of changing weather conditions. Fertilizer plots should be made as simple as possible. It is a mistake to ask too many questions of them at one time. One of the simplest arrangements is that in which the nitrogen, phosphoric acid, and potash are applied by twos, one plot having nitrogen and phosphoric acid, the next nitrogen and potash, then potash and phosphoric acid, then all three, and then one or more check plots without fertilizers. If plots 1 and 2 are almost as good as plot 4 with the complete fertilizer, while plot 3 is but little better than the check, it shows clearly that nitrogen is the element most needed. On the other hand, if plots 1, 3, and 4 are decidedly better than 2, it shows a shortage of phosphoric acid; while if 2, 3, and 4 are better than 1, potash is indicated as most needed. If 4 is decidedly better than 1, 2, and 3, then all three elements are depleted and a complete fertilizer is required. If it is desired to determine whether or not liming of the soil is needed, a convenient method is to divide the experimental field in half by a

line crossing the different plots. Either slacked lime or finely ground limestone should be applied to one half and not to the other. In this way one half of each plot will receive lime, and its effect can be studied with each of the different fertilizer combinations, and the effect of lime alone on the check plots.

Useful indications as to the need for phosphoric acid and potash can often be secured by analyses of the cane juices. If the juices run low in these elements, it indicates a deficiency in the soil. Such deficiency, particularly of phosphoric acid, often leads to difficulty in defecation and to the production of too large a proportion of molasses.

By combining the three methods of soil analyses, juice analysis, and plot experimentation, a fairly safe conclusion can be reached as to fertilizer requirements; but this should always be checked up and verified by actual results on a field scale.

Fortunately, cane when properly handled is not a crop which exhausts the soil rapidly. Sugar itself takes nothing from the soil, being very different in this respect from any of the grains. Where the trash is not burned, but is allowed to rot and be finally reincorporated in the soil, about the only losses of mineral elements are from erosion and the fertilizing ingredients of the bagasse and molasses. Losses of nitrogen, however, occur from the fermentation of organic matter in the soil, which is greatly hastened when the soil is stirred by tillage. On very many cane soils, nitrogen is the first element to become exhausted. This accounts for the uniformly good effect of stable or pen manure. This not only furnishes available nitrogen but, especially on heavy soils, it improves the mechanical condition, making the soil more open and porous. It also has a stimulating effect on the growth of soil bacteria and the other biological activities on which fertility so largely depends. If an abundance of stable manure were available, no other fertilizer would be required on most cane soils. This, however, is far from being the case, and with the rapid substitution of tractors for animal power on the plantations, the present limited supply is rapidly diminishing. The filter-press cake, or *cachasa*, from the mills, serves much the same purposes as stable manure, only about half the quantity being required to obtain equally good results. The value of this material is not always appreciated. Even when carried to the fields, it is likely to be applied wastefully in unnecessarily large quantities. It should be carefully saved and applied to fields that are being prepared for planting. It is more economically and uniformly applied by manure spreaders than can be done by hand. The expense of carry-

ing it into and applying it to fields of growing cane is usually too great.

The only other substitute for stable manure consists in the plowing under of leguminous cover crops. Unquestionably, a crop of legumes should be grown whenever a field on old lands is plowed up for replanting. This, however, occurs so infrequently in most cane-growing countries that green manuring can only be a minor factor in maintaining soil fertility. We must depend in great part on the conservation of the cane trash for maintaining the soil humus which plays so important a part in crop production.

Everything considered, cowpeas are the most satisfactory crop for green manuring. They grow so quickly that the field only needs to be laid out of cane production for about three months. Cowpeas grow readily, without the necessity for root-nodule inoculation, on practically all cane soils, and they always have so good an effect on the following crop as amply to repay the cost of planting them. In order to secure the best results, seeding should be heavy, at the rate of about 2 bushels per acre. The seed may be broadcasted and harrowed in, but better results usually follow planting with a drill. An ordinary grain drill with half the outlets plugged up gives perfectly satisfactory results. When drawn by a small tractor, such an outfit can seed a large area in a day. Many other legumes are also employed for green manuring. Most of them require a longer time for maturing than the cowpeas and so do not fit as well into the requirements of cane agriculture. Among the most important of these are velvet beans, jack beans (*Canavalia* sp.), lab-lab beans (*Dolichos lab-lab*), sun hemp (*Crotolaria juncia*), tropical lima beans (*Phaseolus lunata*), and Pigeon peas (*Cajainus indicus*). Soybeans, alfalfa, and sweet clover are not so well adapted to most tropical conditions.

The planting of legumes inter-culturally between cane rows has often been suggested, and when tried experimentally it has given good results, but for some reason it has nowhere been adopted extensively in ordinary field practice. Theoretically, the idea is most attractive. If the cultivated middles were planted to legumes at the beginning of the rainy season, they would keep down grass and save expensive cultivations, while at the same time they would be adding nitrogen and humus to the soil. Only low-growing bush forms would be available for this purpose. Vines of any kind would be very objectionable. Bush varieties of cowpeas, like the whippoorwill or the small, white-seeded jack bean (*Canavalia ensiformis*), are the kinds usually recommended for interplanting. No valid objection to interplanting with legumes has ever been raised. The failure to adopt

it on a field scale seems to be entirely due to that peculiar inertia and lack of initiative so characteristic of sugar-cane agriculture.

After utilizing all of the stable manure, filter-press cake, and green manuring that are available or practicable, we find that the lack of sufficient nitrogen is still the limiting factor in production on almost all old cane lands. This must be supplied by commercial fertilizers. Cane is a gross feeder, and has such a long growing season that almost any source of nitrogen can be utilized. We have our choice of nitrate of soda, nitrate of potash, nitrate of lime, sulphate of ammonia, cyanamid, or the various organics, including fish scrap, cotton-seed meal, and tankage. Usually we need only consider unit prices and buy the form that furnishes the pound of nitrogen at the cheapest rate. When early maturity is a vital factor, however, the organics should be avoided and most of the nitrogen used should be in the form of nitrates, applied very early in the season. These are the quickest-acting of any of the nitrogenous fertilizers. They will give the crop a quick early growth, and their effects will be largely gone in time to permit of early ripening. The ammoniates and organics, especially if applied late, tend to keep the crop growing late in the season. This may be a decided advantage in the tropics, but it is fatal when the crop must be cut early to avoid danger from frost.

In many tropical countries, especially those with a clay-loam soil, sulphate of ammonia used alone has come to be the standard fertilizer. Such soils are strong in phosphates and potash, and these do not become exhausted as quickly as the nitrogen. It is only a question of time, however, when under constant cropping, even on the heaviest soils, these elements will also become exhausted. The field management should always be on the alert to determine when the time has come to substitute a complete fertilizer for the one carrying only nitrogen. On many soils, particularly those of the lighter types, complete fertilizers will be needed from the first.

There are other considerable soil areas, of which the tropical, coral, red lands are prominent examples, where phosphoric acid rather than nitrogen is the first element to become exhausted, and where this lack quickly becomes the limiting factor in production. On such soils applications of nitrogen alone give little or no result, but they quickly and readily respond to the phosphates. Usually both nitrogen and phosphoric acid are required. Nowhere do plot experiments give clearer or more unmistakable results than in these lands.

Potash, while very essential to the growth of sugar cane and the normal production of sugar, is less often conspicuously lacking in

cane soils. There are many cases, however, when insufficient potash is the limiting factor. This is more likely to occur with sandy loams or with peaty soils, yet there are some clays that are also deficient. This only illustrates the necessity for a careful study of the requirements of each soil type. When in doubt, use a complete fertilizer as a precaution.

Once the nature of the fertilizer required has been carefully determined, there still remain the questions of the proper time and method of the application and the quantity that can be used profitably. It is useless to secure large yields by heavy applications of fertilizer if such increases do not show a fair profit. Here is a point where the judgment of the field management must be called into play, for the final result of profit or loss will depend on market as well as on field conditions. Then, too, the law of diminishing returns must be considered. Heavy applications of fertilizers always give less proportional yields than smaller ones.

In determining the time for making applications of fertilizers, several points must be considered. The most important of these are the nature of the fertilizing material and the proposed time of harvest. Stable manure and press cake should be broadcast and plowed in, in advance of planting. They can be handled economically in no other way. Very soluble fertilizer, like nitrate of soda, may be applied at any time when in the judgment of the manager an added stimulant is needed, since this is in a form to be immediately available to the cane plant. Most commercial fertilizers, however, have to undergo chemical changes in the soil before they can be utilized by the crop, and they must therefore be applied in advance of the time when really needed. It is quite certain that a large part of the fertilizer applications to cane are made too late to secure the best results. There seems to be a widespread but unfounded impression that applications made early, before a well-developed root system is formed, may be largely lost by leaching. This is a mistake, for two reasons. In the first place, fertilizers leach very slowly from most cane soils, and, in the second place, one of the most important effects of a fertilizer is the securing of a quick, early, vigorous growth with a correspondingly rapid development of the root system. To make sure that this root system is developed deeply enough to insure safety in dry weather, it is necessary that the fertilizer be placed deeply in the planting furrow. No subsequent superficial application can take the place of fertilizer in the bottom of the planting furrow, and yet many planters seem to fear to use it in this way. They not only fear that it will be lost by leaching before the roots develop to

absorb it, but they fear that it will injure the young plant, especially if the weather turns dry. Now, the facts are that nothing gives better assurance against drought than a good dose of fertilizer in the bottom of the planting furrow. It not only stimulates an early and deep root development but, by furnishing a richer soil solution, it enables the plant to take up sufficient food with a smaller water supply. The weaker the soil solution, the more of it must be taken up by the plant and transpired in order to obtain the needed supply of mineral plant food. Then, too, even in the tropics, the actual growing season is usually short on account of the unequal distribution of the rainfall. In order to obtain maximum tonnage, the fertilizer must be in the soil and have undergone the changes necessary to make it available before the coming of real growing weather. Otherwise, a part of the available growing season will be lost.

It is of great importance to secure a maximum growth early, for this not only saves expense by the quicker closing in of the cane, but it allows time for the proper ripening of the cane before harvesting. Where fertilizers are applied late, especially the slow-acting organic fertilizers, the tendency is to force growth late in the season, thus preventing early maturity. This point is of most importance in those semi-tropical countries where cane has to be cut before full maturity on account of danger from frost. Under these conditions all of the fertilizer had best be applied with the seed cane. In the tropics, late maturity may be an advantage in those fields that are to go over for cutting at the end of the crop, for there will be less danger of deterioration from over-ripeness. Fields intended for early cutting should get all of their fertilizer early, while those intended for late cutting had better get half at planting and the balance as a second application when the cane is laid by at the last cultivation. With ratoon fields, the only proper time to apply fertilizer is when the cane is first off-barred, as soon as possible after lining the trash. This gets it down fairly deep, where it will be well covered by the soil in subsequent cultivations. The method current in some districts, of throwing the fertilizer on top of the ground and trusting to its being covered later with hoes, is very wasteful, and the cane never gives the best results or full value for the money expended. With ordinary short-crop ratoons it is usually best to apply all the fertilizer at this one application for the growing season is short at best. For long-crop ratoons that are to be carried over to the second year, a second application is indicated.

The only fertilizing material that can be properly applied as a surface dressing without covering is nitrate of soda. This is so

soluble that it will be quickly dissolved and made available by the dew. Its use in this way is only advisable in dry weather, for it would be washed away and lost in a heavy rainfall. All other fertilizers need to be covered in the soil in order to undergo those changes needed to make them available as plant food. This is a point that should not be lost sight of. Roots will always go to the fertilizer. The deeper it is placed, the deeper will be the resulting root system.

To recapitulate: A part at least of the fertilizer should always be scattered in the planting furrow in advance of the seed. With ratoon fields this application should be given in the furrow made at the side of the stubble when off-barring, and as soon as possible after the cane is cut. Where fields are to be cut early, either on account of freezing weather or for the beginning of the crop season, it is usually best to apply all of the fertilizer at this one operation. For fields intended for late cutting, or for carrying over to the second year, only half of the fertilizer should be applied early and the remainder at the last cultivation before the field is laid by. Often it is more convenient to apply all of the phosphoric acid and potash with this first application, reserving half of the nitrogen only for the second. For this purpose, either sulphate of ammonia or nitrate of soda can be used before the last cultivation, and if desirable a third application of nitrate alone can be broadcast by hand among the standing cane after the field has closed in. Where cane is irrigated, these late applications may be made by dissolving nitrate of soda in the irrigation water.

In the literature, statements will often be found that while one can increase tonnage by the use of fertilizers these do not affect sugar content. Other writers caution that fertilized cane will be less rich in sugar than that which is not fertilized. Both of these sets of writers ignore the fact that sugar content is more dependent on ripeness than on any other one factor. It is more important even than variety, for a well-ripened sample of low-sucrose varieties will show more sugar than immature cane of the highest sucrose kinds. In fact, most of the varieties that are reputed to be low in sucrose are simply those that are late in maturing. Now there can be no question whatever that the kind and amount of fertilizer used, and the time and method of its application, will profoundly affect the ripening of the cane. This is the point that has been kept prominently in view in the above discussion, and a usage has been suggested that will tend to give mature but not over-ripe cane at the time of cutting. It is perhaps a fact that within certain limits the fertilizer used will not affect the sucrose content of the cane if each lot is allowed to

reach full maturity. This question, however, has never been sufficiently studied, and we have but little real knowledge concerning it. The prevailing opinion, however, that cane from poor, stunted fields is richer than that from fields that are well grown, is not well founded. Such cane is likely to have dried without really maturing, and when this happens it is low in sucrose and purity. It is really remarkable that with the countless numbers of fertilizer experiments that have been made and recorded in the literature, there are so few that throw any real light on the effect of the different fertilizing elements on maturity or on the ultimate composition of the cane. We do know from experiments with other crops that the general effect of both nitrogen and potash is to retard maturity, and that of the phosphates to hasten it. Presumably this is also true with cane, but it does not seem to have been proven experimentally. Again, we know from juice analyses that cane from fields lacking in phosphates and potash contains less of these elements and gives juices lower in purity and harder to defecate properly than cane from richer soils. Doubtless, applications of phosphoric acid and potash will correct this difficulty. If so, they will have had a direct effect on sugar content. Again, we know that cane grown on certain types of soil is always richer and of higher purity than that from other types, and that the proportion of crystallizable sugar and the molasses yield vary widely. Quite certainly these conditions are correlated with the amount of available phosphoric acid and potash contained in these soils. If so, the quality of the cane from the poorer types should be improved by the use of a properly balance corrective fertilizer. So far, however, we seem to have no data proving that this is practicable. Surely this is worth finding out; if the quality of these poorer canes can be improved it means many millions of dollars annually.

Tillage.—This most important question has already been discussed so fully under the different systems of planting that but little remains to be added here. By tillage, as the term is used here, is meant any working of the soil between the rows of planted crops. In the United States such work is usually referred to as cultivation, but in some other countries this term also includes preparation of the land for planting. This last is quite a distinct operation, usually requiring a different and much heavier equipment. It therefore seems best to employ terms that cannot lead to confusion of ideas.

The objects of tillage are threefold: first, to destroy weeds, thus preventing them from robbing and smothering the crop; second, to make and conserve a dust mulch over the surface in order to conserve

moisture during dry weather; third, to break up the crust which forms on most soils after rains or the application of irrigation water, thus providing for the aeration of the soil, and thereby stimulating those biological activities by which the plant food in the soil is made soluble and available, and on which its fertility and productiveness so largely depend. Only the first of these objects is attained by the ordinary "cleaning" with the hoe. Even this is not thoroughly done, since the grass and weeds are usually only scraped off at the surface, and not dug out and destroyed. With the higher wages now prevailing in most cane-growing countries, the cost of hoe cleaning has become prohibitive. Then, too, it requires so large a force of laborers that frequently it cannot be done during the crop season. Nothing can be more disastrous than the widely prevailing custom of leaving all of the field work to be done during the "dead" season after the mill closes down. Implement tillage thus becomes a necessity if for no other reason than because of the far smaller number of laborers required to care properly for the fields during the grinding season. The kinds of implements required and the comparative merits of oxen, mules, and tractors as motive power have already been sufficiently considered. These are all more or less local questions. The main thing is to select the equipment best suited to local conditions, and to see to it that an implement of some kind is passed between the rows whenever it is needed to kill weeds, to preserve a dust mulch, or to break up a crust after rains. Usually a cultivation once every two weeks will accomplish this purpose, but tillage is not a thing that can be done by rule. The manager must be alert and inspect his fields frequently in order to adopt his methods to meet local and seasonal requirements.

A heavy mulch is the only possible substitute for tillage. This too will keep down weeds, it will preserve moisture, and, by protecting the surface of the soil from the compacting effect of rains, it will prevent surface crusting, and keep the soil open enough to provide for aeration. It has the added advantage of shading the soil and thus protecting it from the deleterious effect of prolonged exposure to a tropical sun which, as has already been shown, tends to burn out humus and exhaust fertility. The method of lining the trash in alternate middles in ratoon fields, thus forming a double mulch over half of the surface, is the only one so far devised that provides for combining the advantages of both mulch and tillage, and this at a saving of nearly half the cost of tilling the entire field. Its obvious theoretical advantages have been fully confirmed in extended field practice. Unquestionably, fields so treated will retain their

fertility much longer than those where the trash is burned. The burning of cane fields either before or after cutting must be condemned from every point of view. It increases losses from the moth stalk borer by destroying the borer parasites; it nearly doubles the cost of the subsequent ratoon cultivation; and it most certainly tends to deplete the supply of humus in the soil, thus lowering its fertility. Losses in the chemical elements of fertility can be made good by buying commercial fertilizers. Losses in humus, which changes the mechanical as well as the chemical nature of the soil, cannot be replaced so easily. There is, therefore, the greater necessity for guarding against preventable losses, and of these the loss caused by burning the trash is one of the greatest.

Roadways and Fire-guards.—In every cane plantation there is always necessarily a considerable portion of the total area that is left without planting, for roadways, turn rows, and fire-guards. The proper handling of these vacant spaces is always somewhat of a problem. If they are allowed to grow up in grass they become a fire menace rather than a protection.

It has already been suggested in the discussion on drainage that fields should always be so laid out that the sides of these roadways between them can be utilized as outlet drains by simply piking up the road with a road grader. This serves the double purpose of improving transportation and of freeing the fields of water. This is of great importance. Nothing will do more to improve the permanent value of a plantation than to grade up the roadways properly. After the grading it will still be necessary to keep down grass, either by frequent cultivations or by planting to some crop that will occupy the land closely enough to prevent the growth of grass and will leave no inflammable residues. Sweet potatoes are usually selected for this purpose, and they also serve as a food crop for the laborers. Where no such crop is planted the roadways may be kept clean at comparatively small expense by frequent passes of the four-gang disc harrow drawn by a small tractor. If grass gets too big to be destroyed by the harrow, a shovel cultivator of the "orchard" type may be used. Keeping down the growth of grass and weeds in roadways is necessary not only on account of the fire risk but because the roadways otherwise serve as reservoirs of foul seeds that will be scattered in the fields, making tillage more expensive, and, if grown up in grass, they also serve as nurseries for breeding innumerable quantities of *Aphis maidis* to spread mosaic disease through the fields. Mosaic is now so widely scattered in practicelly all cane-growing regions that its control is one of the major cane problems. Clean roadways and

field margins are thus a factor of even greater importance than formerly.

The Agricultural Policy.—There are two quite distinct methods of securing a cane supply. In one the mill management also handles the field, growing the cane with hired labor, or, as it is called, by administration. In the other the cane is grown by small farmers, usually renters, and is sold to the mill either at a fixed price per ton or, as is more usual, at a price governed by the market value of sugar. In Spanish-speaking countries these small growers are called *colonos,* and hence this is known as the colono system. Each method has its earnest advocates, and each has certain obvious advantages and disadvantages. On many plantations both methods are followed, a part of the cane supply being grown by administration, and a part purchased from colonos.

The administration method has the advantage of being more directly controlled and of being able to command a better equipment. Steam plows and big tractors are too expensive to be within the means of the small farmer. This method is, too, more flexible, and changes in area planted, in methods of cultivation, and in varieties are much easier to make. Its disadvantages seem to be social and political rather than agricultural. From this point of view, a country largely populated by day laborers who are dependent on more or less seasonal employment is much less desirable than one with a population of small farmers. Its greatest disadvantage from an agricultural or economic point of view is that its success depends so absolutely on the personal ability of the local field manager. Perhaps, however, this should be considered as an advantage, since it gives so good an opportunity for the really able men. No industry can continue to prosper that does not attract high ability.

With the colono system, one of the worst drawbacks is that, as a rule, the farmer is without sufficient capital and must depend on advances from the mill for making and harvesting his crop. In only too many cases he manages so poorly that he keeps slipping farther and farther into debt until finally he loses hope of ever being able to pay out, and it becomes his ambition to see how deeply in debt he can get before the company calls a halt. Then, too, there is a widespread impression, sometimes perhaps only too well founded, that it is an advantage to be heavily in debt to the company, since such colonos will be given better facilities for taking off the crop in the hope of making better collections. On a plantation with colonos there is usually a conflict over cane loadings, the mill calling for more cane, while the colonos are demanding more cars. It is more difficult to

secure a uniform, uninterrupted supply than where the harvesting is done directly by administration. The bad debts carried on the books of most plantations that run on the colono system are probably the worst objection to it. It also requires a larger area to supply a mill than where the cane is grown by administration. Each colono needs room for buildings and pastures, and the average yields are less under the colono system. Not all colonos are good farmers. This method works best with new-land plantings where agricultural problems are fewest. Trouble begins as lands become exhausted and require changed methods of cultivation, and especially when emergencies, such as an epidemic of mosaic, appear. Under administration, methods can be completely changed overnight by a few short orders. On the other hand, it takes long argument and often heavy losses to persuade colonos that a change is necessary.

There is great diversity of opinion as to the proper size for cane colonias. Some plantations follow the system of dividing up lands in small tracts of 30 to 60 acres, the idea being to give a man only as much as he and his family can work to advantage themselves. Each field laborer is in effect made a colono, and therefore a partner in the business. At other places the colono is given from 500 to 1000 acres or more, according to his financial and business ability. He is in effect made a local field manager, as in the administration system, but he is paid by being given a percentage of the crop instead of a fixed salary. Theoretically, the idea of the small colonia is very attractive. It not only gives a large population of small farmers, but it seems to solve the ever-troublesome question of a labor supply. In practice, however, many difficulties develop. Much friction usually results from dealing with so many half-independent owners. The worst trouble, however, is that in most cases the colono is interested in keeping as large a part of his area as possible in grass on which to tie out a few cows. His main business is growing cattle and hogs rather than cane. He plants as little as he can without being dispossessed, and that in the crudest possible manner. The larger colono, on the contrary, usually makes cane growing his main business, and he has enough cane to make a good profit if he manages it well. He is a manager, not a laborer. When good men have been secured the system works out quite satisfactorily, and where contracts have been properly drawn, methods can be controlled by the general management much more readily than in the case of the small colono. The difficulty in regard to equipment is often solved by the company owning and operating the steam plows and big tractors, sending them

from place to place as needed, and charging their work up to the colono.

Taking all of the elements of the case into consideration, it is usually the best policy for the mill to grow part of its cane by administration and have part of it grown by carefully selected colonos. The administration fields should always be so well run as to serve as demonstrations of the best methods, and as models to be followed by the colonos.

Harvesting.—All sugar cane is still laboriously cut by hand with the machete. This is the one phase of the industry that calls for a great number of seasonal laborers. When the problem of mechanical harvesting is finally solved, this, which is perhaps the most troublesome feature of the industry, will have disappeared. That successful mechanical harvesting will be achieved in the near future is absolutely certain. This is abundantly demonstrated by the partial success of some of the experimental cane harvesters that have already been constructed. If the industry ever comes to devote to this problem one-tenth of the effort and expense that are given every year for slight improvments in sugar mill machinery, it will be solved within twelve months. So far the initial expenses have practically all been borne by industrial inventors, each working independently and without knowledge of what was being done by others. The machine invented by the late A. N. Hadley probably came nearer to complete success than any of the others so far constructed. He brought it to Cuba from Louisiana and worked with it there during the winters of 1911 and 1912. When seen by the writer it was cutting heavy, tangled cane that had been thrown down by a storm, doing the cutting better than it is done by hand, stripping the cane perfectly, cutting it into convenient lengths, and dropping it directly into a cart being driven alongside. The work could not have been better done, but certain structural weaknesses had developed so that there were frequent breakdowns. Mr. Hadley said that he had all these weak spots located and that they could be easily remedied in building a new machine. He considered the problem as solved, and said he planned to go to New Orleans at once to raise money to build some new machines and that he would be back the next fall ready to take commercial cane-cutting contracts. He went to New Orleans but was taken sick and died shortly after landing. Nothing more has ever been done with this most promising invention. After seeing it at work, one could have no doubt regarding the complete practicability of mechanical harvesting. The company on whose land these trials

were made at that time grew more sugar cane than any other concern in the world; and yet, curiously enough, its president, who chanced to be at that plantation the last day the machine was run, refused to ride a few hundred yards out of his way in order to see it, remarking that he did not want to see it and that any man was a fool who tried to cut cane with a machine. This is hardly believable, but the remark was made in the presence of the writer. Of course, it was an extreme case but it illustrates a rather common attitude in regard to field problems.

After the cane is cut, the next problem is transporting it to the mill. In a few hilly districts with abundant water, it is floated to the mill in flumes. It is only in rare cases, however, that this is practicable. In Demerara it is loaded on flat-boats in the drainage canals and is taken to the mill by water. This, too, is possible only under very unusual conditions. By far the greater part of the cane has to be transported by land. With smaller mills, in the early days of the industry, most of the cane was hauled directly from the field to the mill, either in carts or wagons or in small cars on portable tracks which were moved from field to field as the cane was cut. The enormous modern central factory, however, requires a well-equipped railroad system for bringing in its cane supply. Nearby cane may still be hauled directly to the mill in carts, but most of it goes to loading stations on the railroad where it is transferred to cars by various hoisting devices which pick up the entire cart load and dump it in the car. Portable track is often used in place of carts to bring the cane from the fields to the loading switches. This is very useful in wet weather and especially in fields that incline to be soft, as it prevents injury to the stools from the cutting in of cart wheels. However, it requires an expensive equipment, and it can only be used economically where there are heavy yields. The constant shifting of track is too expensive where only light yields are to be handled. On the whole, the use of portable track is not increasing. Probably a smaller proportion of the cane is being handled in this way than formerly. The introduction of carts mounted on caterpillar or crawler-type trucks has largely obviated the necessity for portable track, since these trucks can pass over quite soft ground without injuring the stools, and, because of their lighter draft, can transport heavier loads with the same motive power than those with the old round wheels.

The greater part of the world's cane is still hauled with oxen, though in Louisiana and some other countries mules are extensively used for this purpose. The use of tractors for hauling cane is increasing rapidly and, without doubt, in the near future a great part of

the cane will be handled in this way. With powerful tractors hauling trains of loaded wagons cane can be transported much longer distances than with cattle, with a corresponding saving in railroad extensions and loading stations for bringing in the crop from outlying fields. In using big tractors for hauling, time will be saved by using either cattle or a small tractor for taking in empties, bringing the loaded wagons out of the fields, and making up trains on the main roadways. For hauling, tractors with caterpillar trucks are much preferable to those with round wheels. They have better traction and are able to go without difficulty over roads so soft as to stall round-wheel tractors. The near future will doubtless see a marked increase in the use of these crawler or caterpillar trucks both for wagons and tractors in the hauling of the cane crop.

Ratooning and the Treatment of Ratoon Fields.—Methods of ratoon or stubble cultivation have been outlined in connection with the different systems of cane planting, but the importance of the subject justifies a recapitulation and further discussion of it here in its proper sequence, following immediately after the harvesting of the crop.

In Java, owing to the legal restriction, based on the necessity of keeping most of the land in food crops, and to the presence of sereh and other diseases, no ratoon cane crops are taken. This basing of the industry entirely on crops of plant cane is only possible on account of the over-abundant and cheap labor supply. In practically all other regions, some portion of the cane supply comes from ratoon fields. There are comparatively few countries where the fields are so managed as to secure the maximum number of profitable ratoon crops. Most of the failures to ratoon properly come from the planting of varieties poorly adapted to local conditions. Thus, on the south coast of Porto Rico, for many years no ratoon crops were taken. This was because they were still planting the Otaheite, or Caña Blanca, a kind that always ratoons poorly and usually fails entirely as the lands become old and compacted, at least with the lack of implement cultivation which characterized old methods of ratooning. When Crystalina came to replace Otaheite in general planting, it was found that this kind would ratoon. The prevailing custom there now is to take at least one ratoon crop. Occasionally this is extended to three or four crops, but the old Otaheite tradition and the lack of really efficient cultivation are still needlessly limiting the number of crops taken. Many fields are being plowed up each year, long before they have reached the possible limit of profitable production. In Cuba, on the contrary, ratooning has been carried too far, at least with

the prevailing lack of cultivation. The low average tonnage in that island is caused by the continued cutting of old, half-abandoned fields that have long passed any possibility of profit. Here the remedy lies not in taking a smaller number of ratoon crops, but in giving such cultivation as will make these crops profitable. It costs four to five times as much to prepare the land and plant and cultivate a new field as it does to care properly for ratoons, and yet the tonnage cut from spring plant cane is often less than that from well-cared-for ratoons. Fall plant cane, which is not cut until sixteen months old, naturally yields more than twelve-month ratoons, but one year's production is lost with fall-planted fields. The Cuban planter does not expect to make any money out of his plant cane fields. He is well satisfied if the first cut covers the costs of planting, depending entirely on the subsequent ratoon crops for a profit. All of these facts show the importance of ratoon crops in the economy of cane production. They indicate, too, the importance of improved methods of cultivation in maintaining the productive life of the plantings, and in reducing the cost per ton of ratoon cane, thus enabling planters to make some profit even at low prices for sugar, and successfully to meet the competition of government-aided beet sugars. It may be taken as axiomatic that sugar beets cannot compete with cane on even terms. They always have been, and probably always must be, artificially favored either by tariff duties or direct bounties in the effort of the various countries to build up an independent sugar supply.

To recapitulate: To be cheaply produced, cane sugar must largely come from ratoon fields. To keep ratoon fields in profitable production for a series of years on old lands, the following points are necessary:

First, the variety selected must have a good root system and great natural vigor, and it must be adapted to local soil and climatic conditions. These points are of greater importance than extremely high sucrose content. Nearly all of the standard varieties will give satisfactory sucrose and purity if allowed to fully mature.

Second, the trash must not be burned, but must be saved and utilized as a mulch to conserve moisture and cut down the costs of cultivation. Ultimately, it must be incorporated in the soil in order to keep up the supply of humus and maintain fertility. This is best accomplished by lining the trash in alternate middles as soon as possible after the cane is cut, in order to secure the advantages of both a mulch and implement cultivation. This is done best and cheapest by using an ordinary sulky hay rake driven across the rows. The practice of continually burning the trash is inadvisable, not only

because it tends to reduce soil fertility, but because it destroys the parasites that help to control the moth stalk borer, which in many countries is by far the most serious of all sugar-cane pests.

Third, the need for fertilizers must be carefully studied. On most old lands annual applications must be given in order to maintain profitable yields. The kind and quantity of fertilizer to apply is a local question and it must be determined locally. As the growing season for ratoons is short at best, fertilizer must be applied as early as possible in order to secure its full benefits and not to delay unduly the ripening of the crop. It should always be applied in the furrow next the cane when the stubble is first off-barred.

Fourth, implement tillage is an absolute necessity in order to conserve moisture, to aerate the soil and promote nitrification, and to avoid undue expense in keeping down weeds and grass. This tillage should comprise the following operations: off-barring the stubble in the cleared middles as soon as possible after the trash is raked and before the ground has time to dry and bake in the sun; applying fertilizer in the bottom of these furrows; cutting up the furrow slices and covering the fertilizer with two or three passes of a small, reversible disc harrow. Follow this procedure at sufficiently frequent intervals to make and preserve a dust mulch with the fourteenth-tooth harrow cultivator; and finally, substitute with the three-shovel cultivator or the disc harrow at any time that grass gets too big to be destroyed by the harrow cultivator. Do not disturb the trash in the mulched middle with the hoe. If any weeds come up through it, pull them by hand. In irrigated fields apply water in the cultivated middle only. If this simple program is carefully followed, yields can be maintained for at least eight or ten years on any really good cane soil, and in many cases for twice this number of cuttings. Nothing is likely to prevent such long-continued ratooning unless the soil becomes heavily infested with white grubs, root weevils, wireworms, or other root-eating pests, or unless the fields become infected with some of the major cane diseases.

APPENDIX I

AN ANNOTATED LIST OF CANE VARIETIES

A BRIEF history has already been given of certain severe cane epidemics that have devastated first one and then another of the cane-growing regions. In each case the situation has been saved by the substitution of other and more resistant kinds of cane. These facts serve to fix attention on the great importance of the variety question, and especially on the importance of the old, named varieties from which the great bulk of the world's cane sugar is still made, notwithstanding the great flood of new seedlings produced in recent years. With the advent of this modern craze for the breeding of cane seedlings, all interest in the older kinds seems to have been suddenly lost, although each one of them was well enough adapted to its local conditions and had sufficient merit to establish itself in the primitive agriculture of its native region. These varieties are not recently produced and only partially tested seedlings, selected by the whim of some plant breeder; most of them have persisted for generations through the half-conscious selection of practical agriculturists. Evidently they have filled some local need. For this reason, if for no other, they should receive more serious attention than has been given them during the past twenty years by either cane breeders or plantation managers.

This lack of interest in the older kinds was doubtless largely due to the widespread but mistaken view that cane varieties constantly tend to run out or degenerate and that consequently it is necessary to have new kinds with which to replace the old ones. The breeding of new kinds is useful and should by all means be continued, especially where the effort is to combine the best chacracters of the older strains, but it should not cause us to neglect the study of these old kinds which represent the best breeding results of all the ages.

The following list of cane varietal names is confessedly incomplete although it represents a careful search of all the available literature. It was first published in the Journal of the Department of Agriculture of Porto Rico, Vol. 4, No. 3, dated as of July, 1920, but not issued until April, 1921. It was hoped that it might attract enough attention to bring out from others additional lists of names that had been omitted, but such has only been the case in a few instances. Most of the names added here have come from current readings in sugar-cane literature. Unquestionably, many of these names are synonyms, since the pernicious custom of renaming varieties has

been widely followed. Where such synonyms have been detected, the fact is noted in the text, and the authority for the determination is indicated. As was stated in the first edition of this list, it can hardly be called a contribution to knowledge but is rather intended to call attention to our lack of knowledge of most of these kinds, and has been published in the hope that it may lead those having access to collections of these old varieties to study them more carefully, and especially to publish recognizable descriptions of them for the guidance of other workers.

No attempt has been made to list the innumerable new numbered seedlings, but the initials under which they are enumerated have been listed in so far as it has been possible to ascertain them.

As the following varietal names are in alphabetical order, they are not repeated in the Index.

A.—(As an initial with numbers) = Antigua Seedling.

Aboe.—Mauritius Bot. Gar. 1869, Horn; Queensland, from Java, 1874, Easterby; Java, from Amboina, 1896, Wakker. White Aboe, Mauritius, 1869 = White Rappoe. Rappoe is a name that has been rather loosely applied but it is usually = Light Cheribon, or = Crystalina.

Agaul.—So. Afr. Sug. Jour., Sept., 1919. Recently introduced to Natal from India. Resembles Uba but seems to surpass it in vigor. Susceptible to both mosaic and streak diseases, Storey. Rept. Imp. Bot. Congress 1924, p. 137 (Pansahi group).

Agholi.—India, N. W. Prov., Watts Dict. 6 (2); 62, 1893.

Agoeng.—Java, Harreveld, Med. 4: 1658, 1919.

Ainakea.—Hawaii, Eckert, Bull. 17, 1906; Deerr, Cane Sugar, 1911; Louisiana, from Hawaii, Stubbs, Agee. A green and red striped cane, but not the striped Bourbon as suggested by Stubbs (Deerr).

Akewa.—Queensland, 1878, Easterby; from New Guinea, Maxwell, 1903–4.

Akilolo.—Louisiana, from Hawaii, Stubbs, Agee. = Manuleto (Stubbs) Hawaii, Rock, 1913.

Albion.—Demerara, Jour. Brit. Gui. 11: 157, 1918; Albion Green, Jamaica Sug. Sta. Rept. 2: 69, 1908 (= D95); Albion Red. Sug. Sta. Rept. 2: 70, 1908 (= D135). According to Mr. Noel Deerr (in lit. 5/25–1921) this is the name of the plantation in Demerara where seedling canes were extensively grown. There is also a plantation of this name in Jamaica.

Aleijada.—Brazil, Deerr, Cane Sugar 36.

Alfoeroe.—Java, from Ambonia, Wakker; Teboe Alfoeroe Soltwedel, Fig. 19. The plate indicates a green striped cane with barrel-shaped internodes and broadly ovate buds.

Altamatti.—Hawaii, Eckert, Deerr; Louisiana, from Hawaii, Agee. = Cavengirie, Deerr, which see (probably a corruption of Otamite).

Amarilla das Antillas.—Argentina, from Brazil, Zerban, 1910. See Cayania (= Otaheite).

Amarilla de Java.—Brazil, The Sugar Cane, 22: 483, 1890; The Sugar Cane 25: 187, 1893.

Amarilla de Otaiti.—Brazil, Moreira, 1876. See Otaheite.

Amarilla del Japon.—Brazil, The Sugar Cane 22: 483, 1890.

Ambar de Egypto.—Argentina, Fawcett, 1916, = POJ 105 (Java).

Ancha.—South Africa, from Formosa, Choles, 1913.

Andjing.—Java, from Sumatra, Wakker, 1896. Teboe Andong, Queensland, from Java, 1878, Easterby.

Ani.—Mauritius, from New Caledonia, Lavignac, The Sugar Cane 2: 674, 1870.

Annamite.—Queensland, from Singapore, 1880, Easterby.

Anson.—Mauritius, from Penang, Horne, 1869.

Antiga.—Brazil, Deerr, Cane Sugar 60 = Cayania = Otaheite.

Anyagyan.—Burma, Watt's Dict. 6(2): 78, 1893.

Applewhaite's Seedling.—Barbados, Rept. 105–7: 23, 1908.

Arabora.—Queensland, from New Guinea, 1895, Easterby.

Ardjoeno.—Mauritius, from Java, Horne, 1869; Queensland, from Java, 1876, Easterby; Java, 1896, Wakker, Geerligs, Soltwedel, Fig. 5. The plate represents a medium-stout, long-jointed, green cane, somewhat yellow by exposure, marked with lines on upper part of internode, slightly staggered, buds ovate. Deerr (in lit. 5/25–21) says this name in Hindi means white and it is often used to describe canes in India.

Ardjuno.—Brazil = Otaheite, Deerr, Cane Sugar 52.

Aripibu.—Brazil, Gorkum, 29, 1915. Aripibu verde, Pernambuco, Bull. 3. An "indigenous," yellow-striped cane.

Ariva.—New Caledonia, Vieillard, 1869; Sagot, 347, 1893.

Armstrong.—Demerara, Harrison and Jenman. Purple, then dark claret, covered with bloom.

Arolam.—Now Caledonia, Vieillard, 1863, Sagot, 347, 1893.

Arundo Saccharifera.—Rumphius, Herb. Amb. 5: 186, 1747. A pre-Linnean scientific name for sugar cane, = *Saccharum officinarum L.*

Asamiga puri.—Asam, Stack, 1883; Watts' Dict. 6 (2): 62, 1893.

Ashy Mauritius.—India, Barber, Studies 2: Mysore Agri. cal. 1915. Thrives in North India, Sayer; Noel Deerr (in lit. 5/25–21). It is some M. P. Seedling with lots of wax, but in some places in India the name has been transferred to White Tana.

Assep (or Woelong).—Java, Krazenbrink, The Sugar Cane 2: 192, 1870. Mauritius, from Java, Horne 1869; Queensland, from Java, 1878, Easterby. Woelong is considered by Gonsalves as = Black Cheribon.

Assoe.—Java, from Sumatra, Wakker, 1896.

Atjeh.—Java, from Sumatra, Wakker, 1896.

Australian (or Maxwell).—Behar, India, Int. Sug. Jour., Oct., 1925, p. 532. An introduced, thick, red cane grown by a few European planters.

Australian Creole.—Australia, Erwin F. Smith, Bacteria 3. 69, 1914. Said by Tryon to resemble Meera and to resist gum disease. Meera

is considered a synonym for Black Cheribon but the Cheribon canes are all subject to gum disease.

Avaë.—Society Islands, Cruzent, 1860; Tahiti, Bennett, The Sugar Cane 6:593, 1874. It is suggested by Deerr (in lit. 5/25–21) that the word is a phonetic spelling of Hawaii as this word is pronounced in the native language.

Aveha.—South Africa, from Formosa, Choles.

Aver.—Java, from Sumatra, Wakker, 1896.

Awie (or Awi).—Java, from Sumatra, Wakker, 1896; Kobus.

Awoe de Pasoeran.—Java, Krajenbrink, The Sugar Cane 2:192, 1870.

Awoe de Peloek Djambie.—Java, Krajenbrink, The Sugar Cane 2:192, 1870.

Ayoena.—Mauritius, The Sugar Cane 2:223, 1870. Presumably from Java since it was written Teboe Ayoena.

B.—(As an initial with numbers) = Barbados Seedling. The long list of seedlings produced by Bovell in Barbados, some of which are extensively cultivated in all parts of the world. A second series of B numbers seems to have been started (see Rept. 1915–17:62, 1917). B following a number indicates a seedling produced in Java by Bouricius.

Ba.—(As an abbreviation with numbers) = another series of Barbados seedlings. See Rept. 1907–9:46, 1910. No explanation of this series has been found. The numbers run into several thousands.

Badila.—(Also spelled Badilla) Queensland, from New Guinea as No. 15, 1896, Maxwell, Easterby, Barbados Rept. 1911; Trinidad, Williams, Bull. 18:72, 1919 (des.). The leading commercial cane of Australia and Fiji. Adapted to low, heavy lands.

Badouka.—Cent. India, Watts' Dict. 6 (2):69, 1893.

Bagelen.—Java, Kobus, Med., 6, 1893.

Bagi.—Assam, Stack, 1883; Watt's Dict. 6(2):62, 1893.

Bahmani.—Bombay, Watt's Dict. 6(2):73, 1893.

Bahr.—India, Watt's Dict. 6(2):70, 1893.

Baidaa.—Java, from Sumatra, Wakker, 1896.

Bajam.—Java, from Sumatra, Wakker, 1896.

Bakhra.—United Prov. India, Barber, Studies 3: Bakre, Watt's Dict. 6(2):62, 1893.

Bali Soerat.—Java, Oost-Java, Med. 9:19.

Bamboe Poetih.—Java, from Fiji, Wakker, 1896.

Bamboo.—(Also written Bamboe, Bambou, and Bambú.) A name widely but loosely applied in sugar-cane literature. It is usually supposed to apply to an erect, green cane with enlarged nodes. Deerr identifies it with the Kulloa of India. Bamboo I and III = Meligeli, Harrison and Jenman. Bamboo II = Bourbon, Harrison and Jenman. Rose Bamboo, Hawaii = Crystalina, Deerr.

Bambou Blanc.—Mauritius, Boname, 1895.

Bambou de Cera.—Brazil, The Sugar Cane 22:483, 1890.

Bambou Jaune.—Réunion, Colson, 1905.

Bambou Rayée.—Mauritius, Boname, 1895; New South Wales, Int. Sug. Jour. 1:506, 1899.

Bambú de Tabandi.—Argentina, from Brazil, Zerban, 1910. In later publications said to = Kavangire.

Bambú Rosada.—Porto Rico, Stahl, 1880; Bambou Rosée, Réunion, Colson, 1905.

Bambú Rosada de Rayas Moradas.—Porto Rico, Stahl, 1880.

Bambú Rouge.—Queensland, from Mauritius, 1902, Easterby.

Bangadya.—Bombay, India, Watt's Dict. 6(2):73, 1893; Knight, Bull. 61, 1914: as Bangdia, Watt's Dict. 6(2):75, where according to Ozanne's classification it includes Kabara, Bharal, Bhonga, Rambali, Ramurasdali, Rudraganthi, and Dhamne.

Bangla.—India, Watt's Dict. 6(2):67, 1893.

Bangsa.—India, Watt's Dict. 6(2):57, 1893; Java, from Bovenlanden, Wakker, 1896.

Banjermassing.—Java, Kobus, Med. 6, 1893.

Banjermassing Hitam (or Item).—Java, Wilbrink and Ledebour, Med. 6:86, 1911 = Borneo, Harreveld, Med. 15:1597, 1917.

Banjermassing Poetih.—Java, Kobus, Med. 6, 1893.

Banka.—Java, Med. 25:1. Banka Groen, Banka Rottan, Banka Soerat and Bank wit., Kobus, Med. 6, 1893.

Bansa.—India, Watt's Dict. 6(2):60, 1893; Taylor, Sabour, 1913. Woodhouse, Mem. 7(2), 1915.

Bansbarra.—India, Watt's Dict. 6(2):70, 1893.

Bansi.—Bombay, Barber, Studies 3.

Banteng.—(Also written Banting) Java, Wakker, 1896.

Bantong.—Mauritius, Horne, 1869 (written Teboe Bantong, so presumably from Java).

Bantool.—Java, Harriveld, Med. 15:1597, 1917.

Baraukha.—India, United Prov., Barber, Studies 3; Sabour, Taylor, 1913; Woodhouse, Mem. 7(2) 1915 (see Barookh and Baroukha).

Barbados.—Demerara, Harrison and Jenman = PO-A-OLE (= Cavengirie).

Barbados Native.—Demerara, Harrison and Jenman, = Creole.

Barha.—North India, Barnes.

Barhai.—North India, Barnes.

Barik Pandpuru.—Bombay, Knight, Bull. 61, 1914. A soft white cane.

Barkley.—Jamaica Bull. 2, Bull. 4, 1897. Introduced from Mauritius, 1882. Sir D. Morris. This name does not appear in the Mauritius lists. It seems to be confined to Jamaica. Deerr (in lit. 5/25–21) says it is the name of a former governor of that island and also of a plantation there. Clearly the cane had another name.

Barli.—India, Watt's Dict. 6(2):71, 1893.

Barookh.—Java, from British India, Kobus, Med. 48, 1893. Van Derventer, Handb. 5: 141, brought by Kobus in 1890 (see Baraukha, Baruka, etc.).

Barotamic.—Mauritius, from New Caledonia, Cavignac, Horne, 1869.

Baroukha.—India, Barber, Studies 2 (see Baraukha, etc.)

Baruk.—Behar, India, Deerr, Int. Sug. Jour., Feb., 1925, p. 81. A cane that grows in partially submerged lands. Also, Int. Sug. Jour., Oct., 1925, p. 532, a cane of the Nagori group, semi-aquatic. The name means swamp cane (see Baraukha, etc., also see Kullerah, etc., another swamp cane).

Baruka (or Barukka).—India, Watt's Dict. 6(2): 60, 1893; Papers Sugar, British India, 3d Ap.: 35, 1822 (see Baraukha, etc.).

Bas.—Bombay, Knight, 1914. A soft, ash-colored cane.

Basin.—Bengal, India, Watt's Dict. 6(2): 60, 1893.

Bastard Cane.—Georgia, U. S. A. Yoder, Bull. 486. Local name for a green bud sport from La. Ribbon, = Crystalina.

Bataree (Tabor Bataree).—Queensland, from Straits Settlement, prior to 1828. Easterby, Bull. 2, 1926.

Batavian.—A name occurring widely in the literature; usually used in the same sense as Cheribon, including the Purple, the Striped, and the Light forms. It is mentioned by MacFadyen in Jamaica, by Porter, and by Wray. The name Transparent is often used in apparently the same sense.

Bati.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.

Batjan.—Java, Van Derventer, Kobus. Batjan Groen, Soerat, and Keong are mentioned.

Batoe.—Queensland, from New Guinea, 1895, Easterby, Maxwell; Java, Kobus.

Batoeng.—Java, from Sumatra, Wakker, 1896; Soltwedel, Fig. 4. The plate shows a stout, greenish cane with a reddish flush, much darkened by sooty mould; nodes oblique, slightly constricted; somewhat staggered; buds rather large, suborbicular.

Batramic.—Demerara, Harrison and Jenman.

Batramie.—Jamaica, Bull. 2. Introduced from Mauritius in 1882, D. Morris. Another new name for some old cane.

Batse Purple.—N. S. Wales, Int. Sug. Jour. 1: 506, 1899.

Behar.—North India, Barnes.

Beija Flor.—Pernambuco, Brazil, Bull. 3, Striped.

Belang.—Java, from Sumatra, Wakker, 1896.

Beledi.—Louisiana, from British India, Agee.

Belnoet.—Java, from Sumatra, Wakker, 1896.

Belonguet.—Mauritius, 1850. Also written Ballonguet, Beloguet, Belugué, etc. The name originated in Mauritius from a plantation of that name. It is simply the Black Cheribon = Taboe Batavia (Wray), = To Ute, Society Islands (Daird). Other red canes have been confused

under this name. Some of the Australian references clearly do not belong here. Belugué Blanco, Rayada, and Rojo, Porto Rico (Stahl) are used as synonyms of Salangor Blanco, Rayada, and Rojo. The two latter probably refer to Cheribon canes (see Canne Belonjuet).

Benaresia Nepali.—India, Sabour, Taylor; Woodhouse, Mem. 7(2), 1915. A thick cane closely related to, and possibly identical with, Shamshara (= Otaheite).

Bengal (or Bombay).—Assam, Stack, 1883; Watt's Dict. 6(2). Bengala, from Calcutta, Porto Rico, Lopez Tuero, 1895.

Bengkoeloe.—Java, from Sumatra, Wakker, 1896.

Beraran.—Java, from Borneo, Geerligs, Med. West Java 27.

Besi.—Java, Med. Oost Java 11: 30.

Betakali of Dumraon.—North India, Barnes.

Bete Bete.—Mauritius, Bouton, 1863. See Canne Malabar. (Perhaps = Striped Cheribon.)

Betong.—Java, from Bovenlanden, Wakker, 1896.

Betta.—Bombay, Knight. See Khadya.

BF.—(As initials with numbers: Beija Flor, Pernambuco, Brazil, Bull. 3, da Estacao Exp. de Canna de Assucar.

BH.—(As initials with numbers): Barbados Hybrid, used for hybrid seedlings of known parentage by Bovell in Barbados. The celebrated BH 10(12) belongs in this series. The numbers indicate that it is number 10 of the year 1912.

Bhabeli.—Assam, Stack, 1883; Watt's Dict. 6(2): 62, = Kamrange.

Bhanisiawarchota.—India, Watt's Dict. 6(2): 71.

Bharal.—India, Watt's Dict. 6(2): 72.

Bhoronga.—India, Watt's Dict. 6(2): 60.

Bhunli.—Bengal, Chapman, Watt's Dict. 6(2)60.

Bhuri.—Sabour, India, Taylor; Woodhouse, Mem. 7(2) (see Bombay).

Bhurli.—India, Shahbad, Watt's Dict. 6(2): 60; Java, from British India, Kobus. Behar India, a cane of the Mungo group, Int. Sug. Jour., Oct., 1925, p. 532.

Bhurree.—Cent. India, Watt's Dict. 6(2): 69 (see Bhuri).

Big Bellaint.—Queensland, from Mauritius, Easterby. (Probably a corruption of Belonguet.)

Big Elephant.—Queensland, McDonald, The Sugar Cane, 14: 423, 1882 (see Elephant).

Big Ribbon.—Queensland, from Caledonia, Caldwell, = Caledonia Ribbon, J. Davidson, 1880. Introduced from Honolulu, 1895, Easterby, = Striped Tanna, Deerr.

Big Tanna.—Mauritius, 1922, Walters; Reunion, Coleson, 1893; Barbados, Rept. 1917–19: 60 (see Tanna).

Big Tanna Rayée.—Queensland, from Mauritius, 1901, Easterby (Striped Tanna).

Big Yellow.—Queensland, 1880, J. Davidson, desc. (Seems to = Yellow Caledonia.) McDonald, 1882, writes "Big Yellow or Caledonian Ribbon." Easterby reports Big Yellow as a sport of Big Ribbon.

Biladi.—Egypt, Int. Sug. Jour., March, 1923, p. 137. Review of W. J. Hall, Bull. 26, 1922, on *Pseudococcus sacchari,* mentions the old red tropical Biladi cane, now replaced by thin Java 105 (POJ), except as planted for chewing.

Bile.—Bombay, India, Watt's Dict. 6(2): 73. Bily, Madras, Watt's Dict. 6(2): 76.

Billiton.—Java, Knijper, Med. 7: 814, 1917.

Billy-Cabo.—India, Papers-Sugar, etc., 3d Ap. 17, 1882 (see Bile).

Bira.—Java, from Sumatra, Wakker, 1896.

Bird.—Louisiana, Stubbs. A light purple bud sport from Louisiana Ribbon. Queensland, from Louisiana, Easterby, 1905.

Bittong Beraboo.— = Salangor, Wray, Deerr.

Black Borneo.—Schwarze Borneorohr = Tebu Item, Borneo, Kruger : 141

Black Cane.—Jamaica, MacFadyen; New South Wales (= Black Cheribon); Java, Gonsalves, = Teboe Woeling, Teboe Item, Teboe Moujet, and Canne Violette of Humbolt and Bonpland in part (= Black Cheribon). Brazil = Black Tanna, Deerr, Pernambuco, Brazil, = Port Mackay, Int. Sug. Jour. 1: 378, 1899 (= Cavengirie).

Black Cane of Jamaica.—Argentina, = Morada (= Black Cheribon).

Black Cane of New Caledonia.—Mauritius, Horne, 1869 (= Black Tanna).

Black Cheribon.—Swarze oder Cheribonrohr, = Gonsalves, Zwartreit, Tebu Item (Tmoujit), Tebu Tjeribon, Canne Violette, Kruger, = Belonguet, Black Java, Dark Bamboo, Diaird, Gonzalves, Meera, Moore's Purple, Purple Bamboo, Purple Mauritius, Purple Violet, Queensland Creole, Tabor Numa, Tebboe Etam, Deerr.

Black Creole.—Jamaica, West Ind. Bull. 6: 329, 1906 (= Louisiana Purple).

Black Fiji.—Queensland, from Mauritius, Easterby, 1878.

Black Imperial.—Sagot: 328, = Canne Violette de Batavia (= Black Cheribon).

Black Innes.—(A Mauritius seedling (?) grown under this name in Queensland), Natal. Susceptible to both mosaic and streak disease, Storey, Rept. Imp. Bot. Congress 137, 1924. A popular kind in Australia, Facts About Sugar 1/17–25, p. 50.

Black Issacs.—New South Wales, Int. Sug. Jour. 1: 506, 1899.

Black Java.—Usually = Black Cheribon, but in Mauritius Boname (Rept. 1896) notes two different canes under this name, one resembling Otamite (?) and the other Port Mackay (= Cavengirie). In Queensland, Davidson, 1880, makes it = Chicaca of the Queensland Botanic Garden, Mapou from Mauritius, Mma Cane from New Caledonia (Caldwell), and Tibbou Etam from Batavia (Wray). He describes it as having "cane itch strong," which throws it out of Black Cheribon which has glabrous leaf sheaths.

Black Manila.—(See Inalmon.)

Black Nepaul.—Mentioned by Wray.

Black Ribbon.—Jamaica, = Mam Blam.

Black Tanna.—Queensland, from Mauritius, Easterby, 1878. A local sport from Striped Tanna, Mauritius, Dept. Agr. Bull. 2:5, 1916. Has no synonyms, Deerr and Eckert, Hawaii Bull. 26:16, 1908.

Blackman's Seedling.—Barbados (see Sealey's Seedling).

Blambidjie.—Java, from Malacca, Wakker, 1896.

Blanca de Otaheite.—Louisiana, Stubbs (= Otaheite, Caña Blanca).

Blanchet 2.—Guadaloupe, Sta. Rept. 1922–23.

Blonga.—Bombay, India, Watt's Dict. 6(2):—74.

Blorek.—East Java, Med. 11: 29.

Blue.— = Crystalina, Deerr.

Blue Ribbon.—Tortolo, Virgin Isl., B. W. I., Rept. Imp. Dept. Agr. 1817–18:3. Virgin Isl., Bull. 2:18, 1921. Seems to = Striped Cheribon.

B. N. H.—Barbados, as initials with number, natural hybrids from "checker board" plantings.

Boadilla.—Mauritius, from Australia, Bull. 22:32, 1910. (A misprint for Badila.)

Bodi.—North India, Barnes.

Boeloeh Balik.—Java, from Borneo, Wakker, 1896.

Boeloeh Gading.—Java, from Borneo, Wakker, 1896.

Boelver.—Java, from Sumatra, Wakker, 1896.

Boelver Koering.—Java, from Sumatra, Wakker, 1896.

Bogela.—Queensland, from Fiji, 1915, as 8 NG 105, Easterby, Bull. 2, 1926.

Boiepe.—New Caledonia, Vieillard, 1863, Sagot: 348.

Boinliona.—New Caledonia, Vieillard, 1863, Sagot: 346.

Bois Rouge.—Mauritius, from New Caledonia, about 1870. Dept. Agr. Bull. 2:11, 1916; Demerara = Bournonappa, Harrison and Jenman; Queensland, Maxwell, Easterby; Porto Rico, Stahl, 1880 = Palo Rojo; Brazil = Vermehla, Deerr; Argentina, from Brazil, Zerban.

Bois Rouge Blond.—Porto Rico, Stahl, 1880; Réunion, Sagot, 330, 1893.

Bombay.—Bengal and Asam, not known under this name in Bombay. A red cane, probably from Mauritius, Watt's Dict. 6(2):76; Sabour, India, Taylor, = Red Bombay, = Bhuri, Woodhouse.

Bonsi.—Central India, Watt's Dict. 6(2):69.

Bont.—Queensland, from Java, 1916; Java, 100, Easterby, Bull. 2, 1926.

Bontha.—Louisiana, from British India, Agee.

Borbon.—(See Bourbon.) Porto Rico, Stahl, Loqez Tuero. Both consider it as distinct from Otaheite.

Borneo.—Mauritius, Boname, 1895; Java, Van Derwinter, 1915, = Bandjarmassing Item. Queensland, from Mauritius, 1902, Easterby; Argentina, from Brazil, = Tebu Merah Borneo, (Kruger)?

Borneo Idjo.—Java, Med. 6, 1893, Kobus.

Borneo Item.—Java, Med. 6, 1893, Kobus.

Borneo Rouge.—Queensland, from Mauritius, 1901, Easterby.

Borneo Soerat.—Java, Med. 6, 1893, Kobus.

Borou.—Queensland, from So. Sea Islands, 1874, Easterby.

Bote.—Queensland, from So. Sea Islands, 1874, Easterby.

Bouranappa.—Jamaica (see Bouronappa).

Bourbon.—Usually used as = Otaheite, which see for synonyms. Louisiana, Fleishman, 1848 = Louisiana Purple. The color plate is unmistakable. Louisiana, Stubbs = Crystalina; Trinidad. Hart suggests that there are several yellow varieties included under this name. Australia, from Queensland, not Bourbon of the West Indies. It is Bamboo, Melmouth Hall, 1873. Queensland, 1880, Davidson says = Taboe Leeut of Singapore (Salangor), Taboe Otaheite of Java, Green and Yellow of Mauritius (both should be Otaheite), but adds, "cane itch none," so evidently some other cane, since Otaheite has a well-developed vestiture on the sheaths. Egypt, Tiernann writes, "This red cane apparently springs from the Bourbon or is identical with it." Java, a red cane, not Bourbon of the West Indies, Deerr. Argentina, introduced from Brazil, seems distinct from the Bourbon of the West Indies, Zerban.

Bourbon Purple.—So. Africa, from Bourbon, Choles.

Bouron.—Mauritius, from New Caledonia (Lavignac) 1870, Horne.

Bouronappa.—Jamaica, from Mauritius, 1882, D. Morris, Demerara = Bois Rouge, Harrison and Jenman (see Bouranappa).

Bouron Vapoa.—Mauritius, from New Caledonia (Lavignac) 1870, Horne.

Bourow.—Jamaica, from Mauritius, 1882. D. Morris = Bois Rouge, Bot. Bull. 4: 227, 1897 (see Bouron).

Branche Blanche.—Java, from Mauritius, Wakker, 1896. Soltwedel, Fig. 25, represents a medium-stout, claret-red cane with a bronze stripe; the text says leaves often show white striping. Three canes are represented, the center one darker-colored and without stripes, buds rather large, ovate-triangular. It is clearly Cavengirie although the buds are not typical. Soltwedel evidently did not appreciate bud characters and was careless in drawing them.

Branchu Blanche.—Mauritius, a self-colored sport of Branchu Rayée. = Cavengirie, Deerr.

Branchu Rayée.—Mauritius, = Tibboo Soerat Mauritius, Deerr. This seems to be an error since Teboe Soerat Mauritius, Soltwedel, Fig. 24, is entirely distinct from Cavengirie. Deerr (2nd. Ed., p. 58) in a note under the Tip canes of Hawaii, says "very similar to certain canes found in Mauritius under the names Branchu Rayée and Branchu Blanche." This seems to confirm the fact that his earlier determination as = Cavengirie was an error.

Bra-oto.—New Caledonia (Breslau) 1884, Sagot, 3399.

Brate Mie.—New Caledonia (Breslau) 1884, 339.

Brate Pa.—New Caledonia (Breslau) 1884, Sagot, 339.

Brava de Perico.—A local name in Cuba.

Brazilian.—Used by Porter, 1943, for the cane grown in the West Indies before the introduction of Otaheite, = Creole.

Brea.—Mauritius, Boname, Rept. 1898–9.

Breheret.—Jamaica, from Mauritius, 1882, Sir D. Morris; Demerara (spelled Brekeret), Harrison and Jenman; Java, from Malacca, Wakker, 1896; Louisiana, from Jamaica, Stubbs, Agee. The name seems to have originated in Jamaica.

Brighton Seedlings.—Brighton estate, St. Kitts, 60 seedlings produced and tested, Imp. Dept. Rept. Leeward Isl., 1916–18: 75, 1919.

Brisbane.—Jamaica, from Mauritius, Sir D. Morris, 1882; Louisiana, from Jamaica, Agee, = Green Rose Ribbon, Stubbs, Deerr.

Bronzeada.—Brazil, = Roxina, Deerr.

Brown Pink.—Queensland, from Botanical Garden (Spiller), Davidson, 1880, "itch plentiful."

B (ruicius).—As initial following numbers in Java, indicates seedlings produced by Bruicius. Many of them are crosses with Red Fiji, which resist sereh.

BSF.—Barbados (as initials with numbers). Seedlings from bagged and self-fertilized seed, Rept. 1908–10: 31, 1911.

Bulacan Mestiza.—Philippines, Facts About Sugar 5/18–25, p. 379.

Bullock Heart.—Hawaii, = Cavengirie.

Bundaberg.—Queensland, = D 1135, Easterby.

Bundya.—Bombay, = Pahdhra, Watt's Dict. 5(2): 73.

Burk.—Barbados, a chance seedling named for the overseer who discovered it, Bovell, West Ind. Bull. 2: 25, 1901; Demerara, Harrison and Jenman, = Crystalina, Deerr.

Burra.—A local name in Cuba. Usually applied to a cane resembling Bambu Blanca.

Burra Chunnee.—India, United Provinces, Barber, Studies 3 (see Chunnee).

Buxaria.—India, Taylor, Woodhouse.

Caanan.—Jamaica, Sug. Exp. Rept. 1905: 54.

Cadjoolee.—India, Papers—Sugar, etc., 1822, a thick purple cane mentioned, under date of 1792, with a poor colored plate. Said to be the best cane grown there and that people from the West Indies do not know it.

Calencana.—Porto Rico, = Imperial de Brazil, Stahl, 1880 (Green Ribbon).

Caledonia.—Louisiana, from Demerara, Agee, 1911.

Caledonian Queen.—Trinidad, a provisional name proposed by Mr. Purdie, 1879. No mention of origin. The first importations into Trinidad seem to have been by number, and names were applied later according to fancy. Jamaica, Bull. 4: 227, 1897, = Java, = Hope, = White Elephant; Barbados, Rept. 1905–7; Louisiana, from Demerara, Agee; Demerara, = White Transparent, Harrison and Jenman.

Caledonian Rayée.—Guadaloupe, recently introduced from New Caledonia, Boname, 1888; Mauritius and Réunion, from New Caledonia, Sagot: 328, 1893 (= Striped Tanna).

Caledonian Ribbon.—Queensland, from Caledonia, prior to 1878, Easterby, Bull. 2, 1926.

Calvacante.—Brazil, = Manteiga, Deerr (see Cavalcanti).

Camfia.—Amboina, Rumphius, a native name for sugar cane.

Canaan Cane.—Jamaica, Rept. 3:81, 1911 (see Caanan).

Caña Blanca.—Porto Rico, Stahl, Lopez Tuero. The common Spanish-American name for Otaheite.

Caña Creama.—Porto Rico. A local name rather loosely applied.

Caña Cristalina de Otahiti.—Porto Rico A. R. Quiñones, imported from Cuba before 1877 (= Calancana).

Caña de Cintas Moradas de Bengala.—Porto Rico, A. R. Quiñones, imported from Cuba before 1877 (= Rayada, Striped Preanger).

Caña de India.—Argentina (see Otaheite).

Caña de Vino.—Porto Rico. A local name for an unknown purple cane. Also used for the solid-colored Cavengirie *Roja*.

Caña Francesa.—Cuba, Porto Rico. A popular name for Cavengirie.

Caña Morada.—Cuba, = Cavengirie; Negros, Philippines, Walker. The common Spanish-American name for Dark Preanger.

Caña Negra.—Porto Rico, a popular name for the dark, self-colored variant of Cavengirie: Negros, Philippines, Walker. Seems to be used for the purple-leaved cane, = Djamprik.

Caña Roja de Borbon.—Porto Rico, López Tuero (see Crystalina).

Caña Solera.—Sagot, = Otaheite.

Caña Verde.—Porto Rico, Stahl, 1878.

Caña Veteada.—Mexico, Fernandez del Castro = Striped Preanger.

Caña Violeta de Batavia.—Mexico, Fernandez del Castro, = Habanera, leaves are purplish (Djamprik).

Canna da Terra.—Brazil, = Crioula (Creole), Moreira, 1876.

Canna do Governo.—Sao Paulo, Brazil, Sawyer, 1908.

Canna do S. Juliao.—Brazil, Moreira, 1876.

Canna Escoscia S. Simao.—Sao Paulo, Brazil, Sawyer, 1908.

Canna Maca.—Sao Paulo, Brazil, Sawyer, 1908.

Canna Mestica.—Sao Paulo, Brazil, Sawyer, 1908.

Canna Molle.—Brazil, Moreira, 1876.

Canna Rosa.—Sao Paulo; Brazil, Sawyer, 1908.

Canne Bambou.—Mauritius, Bouton, 1863. From the long description this seems to be Crystalina. It is probably the source from which came Rose Bamboo, the name used for this variety in Hawaii.

Canne Beloujuet.—Mauritius, Bouton, 1863. Three numbers are described under this name. No. 1, Canne Rouge (of Bourbon) the Purple Violet or Large Black Java (of Wray), *Saccharum violaceum* Tussac. This probably = Black Cheribon. No. 2 is *Saccharum violaceum* var. *pur-*

pureum; and No. 3 is *Saccharum violaceum* var. *spadeceum* (see Belouguet).

Canne Blanche.—Mauritius, Bouton, 1863, = Canne Jaune (Maurice), Canne de Batavia (Réunion), Taboe Otaheite (Java) *Saccharum officinarum* var. *elongatum* (evidently = Otaheite).

Canne Blanche de Otaiti.—Guadeloupe, Boname, 1888, = Canne de Batavia (Réunion), Canne Jaune (Maurice), Canne Bourbon or d'Otaiti (India, Antilles, etc.). (As here used it seems to = Otaheite.)

Canne Blanche de Tahiti.—Sagot: 324, 1893, = To Uorco, To Vaihi, Canne de Sandwich. It greatly resembles the last (Canne Jaune de Tahiti) but is less juicy. This cane is richest in crystallizable sugar of all known varieties. (Sagot evidently thinks there is more than one Tahiti, a yellow and a white.)

Canne Bonne Blanche.—Jamaica, Tussac, 1808. Green shaded with violet. The Agent at Hope plantation is propagating it as it is rich in sugar. (Doubtless = Crystalina.)

Canne Creole.—Mauritius, Bouton, 1863, = Canne du Pays (Maurice), Canne Blanche du Pays (Bourbon). *Saccharum violaceum* var. *album.*

Canne de Batavia.—Mauritius, Bouton, 1863, = Otaheite, Guadeloupe, Boname, 1888, = Canne Violetta (= Black Cheribon).

Canne de Graine.—Mauritius, Boname, 1895 (see Graine Blanche and Rouge).

Canne de Rurutu.—Sagot: 329, 1893, = To Rurutu (Rurutu), To Rutu (Tahiti).

Canne de Salangore.—See Salangor.

Canne d'Egypte.—Réunion, Colson, 1905.

Canne d'Otaite rubanée.—Guadeloupe, Boname, 1888, the kind most planted in Mauritius and Réunion, probably Canne Guingham or Canne d'Otaiate Rayée (= Striped Preanger).

Canne Diard Rayée.—Guadeloupe, Boname, 1888 (= Striped Preanger).

Canne Diard Rose.—Mauritius, Bouton, 1863 (= Crystalina ?).

Canne Diard Verte.—Mauritius, Bouton, 1863 (= Crystalina ?).

Canne Grosse Verte de Tahiti.—Sagot: 324, 1893, = To Irimotu. "Has much cane itch, is rich in sugar."

Canne Guingham.—Mauritius, Bouton, 1863, = Canne Maillard, Canne Violette (Maurice et Bourbon), Red Ribbon of Batavia (Wray), Teboe Soerat (Java), *Saccharum officinarum* var. *vittatum.* According to Deerr, this = Striped Tanna, but these references would seem to indicate Striped Preanger. There is much confusion between these two kinds in the literature.

Canne Imperial.—Mauritius, from Brazil, 1869. Horne, (= Green Ribbon, Striped Otaheite).

Canne Jaune.—Mauritius, Bouton, 1863, = Otaheite.

Canne Jaune de Tahiti.—Sagot: 334, 1893, = To Avae, Tebbou Otahiti (Java). He designates the following as sub-varieties: Tebbou Njam-

plong (Java), Caña Solera (New Grenada), Canne de Cayenne (Brazil), Canne de Bourbon or d'Otaiti (des Antilles), Cane Jaune (Mauritius) (Otaheite).

Canne Jaune de Taiti.—Jamaica, Tussac, 1808, with Colored Plate 25, Fig. 2 (=Otaheite).

Canne Maillard.—Mauritius, Bouton, 1863, = Canne Guingham.

Canne Malabar.—Mauritius, Bouton, 1863, = Bete Bete. Malabar is usually given as a synonym for Yellow Caledonia. Here it is used for a striped cane, probably Striped Preanger.

Canne Martinique.—Mauritius, from Réunion, Horne, 1869.

Canne Mazerieux.—Mauritius, from Réunion, Horne, 1869.

Canne Morte.—Java, Kobus, 1893, from Malacca, Wakker, 1896, = Fiji, Deerr. Immune to sereh and much used by Bruicius as the staminate parent in his crosses.

Canne Mozambique.—Mauritius, Bouton, 1863, = Canne Novie (Bourbon) *Saccharum, violaceum* var. *nigrum.* Has wine-colored leaves. He believes it came from Madagascar but Diard saw it also in Java (= Djamprik).

Canne Noire.—Guadeloupe, Boname, 1888.

Canne Novie.—Mauritius, Bouton, = Canne Mozambique.

Canne Panoche.—Diamond, 1886, introduced by La Pice from Java, much like Crystalina but earlier (= La Pice, = Crystalina).

Canne Pinang.—Mauritius, Bouton, 1863 (see Salangore).

Canne Purpure.—Sagot: 328, = Cane Violette de Batavia (= Black Cheribon).

Canne Reine Rouge.—Réunion, Sagot : 330, 1893.

Canne Ribbon.—Mauritius, from Brazil, Horne, 1869.

Canne Rocha.—See Salangore, Deerr.

Canne Rouge.—Mauritius, Bouton, 1863. See Canne Belouguet (= Black Cheribon).

Canne Rouge de Java.—Sagot: 329 = Canne Belouguet Rouge (Maurice), Tebbou Rood (Batavia), Tebbou Japparah, Tebbou Mera (Malacca), (= Black Cheribon).

Canne Rubinée.—Jamaica, Tussac, 1808, Plate 25, Fig. 4, = *Saccharum fasceolatum,* called Guingham in Batavia. Sheaths glabrous (clearly = Striped Preanger).

Canne Rubinée de Batavia.—Sagot: 327, = Canne Transparente à Rubens, Red Striped Cane, Fausse Canne Guingham, Canne Diard Rayée (= Striped Preanger).

Canne Rubinée d'Otahiti.—Sagot : 327, = Canne d'Otahiti Rayée, Purple, Striped Cane, Otaheite Ribbon, Tebbou Soerat, Canne Guingham, Canne Maillard. Sheaths glabrous (probably = Striped Tanna but not clearly distinguished from the above).

Canne St. Julien.—Mauritius, from Brazil, Horne, 1869.

Canne Transparente à Rubens.—Sagot: 327. = Canne Rubinée de Batavia (= Striped Preanger).

Canne Uba.—Mauritius, from Brazil, Horne. 1869, "A worthless cane." (Uba).

Canne Verte.—Mauritius, from Brazil, Horne, 1869.

Canne Violette.—Mauritius, Bouton, 1863, = Canne Guingham (= Striped Tanna); Java, Gonsalves = Black Cheribon.

Canne Violette de Batavia.—Sagot: 328, = Canne Purpure, Tebbou Moujet (Cheribon), Tebbou Asee or Woelong (Krawang), Tebbou Itam (Straights Settlements), Purple Violet (India and Louisiana), Black Imperial (Jamaica), Canne d'Otaheite (Bourbon, Mauritius), To Ute (Tahiti) (Black Cheribon) at least for the greater part. To Ute is considered = Djamprik).

Cannhina.—Argentina, from Brazil, Zerban, 1910 (see Cayannhina).

Canninha.—Queensland, from Java, Easterby, 1874.

Canteng.—Queensland, from Java, Easterby, 1874.

Cappor (or Capor).—Wray Queensland, from Java, Easterby, 1878, = Salangore Deerr.

Carandali.—Porto Rico, Stahl, 1880, Lopez Tuero, = Imperial de Brazil (see Calancana) (= Green Ribbon, Striped Otaheite).

Caricabo.—India, Papers—Sugar, 3d, Ap. 114, 1822. A black cane, Madras, Watt's Dict. 6(2)76.

Carp.—Java, used with numbers, Ledeboer, Med. 4: 452, 1917.

Castle.—Barbados, Nos. 1 and 2 are given Rept. 1908–10: 50, 1911.

Cavalcanti.—Brazil, Gorkum, 1915 (see Calvacante).

Cavengirie.—Porto Rico, Stahl, 1880, from New Caledonia, (also spelled Scavengirie, and Covengerie, Lopez Tuero); in Hawaii = Altamattic and Po-a-ole (Stubbs), Port Mackay (in Mauritius, not Java), Bullock Heart (Hawaii), Louzier (Brazil, not Mauritius), Cheribon (Queensland, not Java). Cavengirie or Seavengirie in Mauritius is distinct, Deerr and Eckert. In Argentina probably = Morada del Brazil, Louzier da Maurice, Kissman, Roxa Osema da Sao Sunao, Zerban, Rev. 1: 29, 1910. Java = Branche Blanche, Soltwedel. Queensland = Cheribon, the unstriped form = Outamotee, from New Caledonia, Davidson, = Otamite, Easterby (probably not of Mauritius). (It is not Kavangire of Argentina, Brazil, and Porto Rico.) (See Kavangri, New Caledonia, Breslan, 1884, which is probably the original form and source of the name.)

Cavengirie Negra.—Porto Rico, Earle, 1921. A name proposed for the dark-colored variant without stripes, = Caña negra, a local name, probably, = Cheribon, Queensland.

Cavengirie Rayada.—Porto Rico, Earle, 1921. A local name proposed for a green striped form.

Cavengirie Roja.—Porto Rico, Earle, 1921. A name proposed for the

claret-colored, solid-colored variant without stripes, = Rosita, Sangre de Toro, local names.

Cawnpuri.—North India, Barnes.

Cayania Seedlings.—Porto Rico. A series of numbered seedlings said to have originated at the Experiment Station in French Guiana, from P. H. Yoder, Cairo, Ga.

Cayanna.—Brazil and Argentina (see Otaheite).

Cayanna de Sta. Barbara.—Argentina, from Brazil, Zerban.

Cayanna Rosa.—Argentina, from Brazil (see Rayada del Pais, Zerban).

Cayannhina.—Brazil, Deerr, Argentina, from Brazil, Zerban (see Cannhina and Canninha).

Cayenne.— = Otaheite, Deerr. In Argentina Faucett considers it to be distinct.

Cebu Light Purple.—Philippines, Hines, 1915. A native cane.

Cebu Purple.—Philippines, H. Atherton Lee (in lit. 6/17–21) = Negros Purple, Black Manila, Purple Native, Pampanga Purple, Inalmon, a dark color variant of Luzon White or White Manila. There is also a red variant (see Pampanga Red). Jolo Purple is quite distinct (Lee).

Ceniza.—Porto Rico, Stahl, 1880, = Crystalina. (In common use in this sense in eastern Cuba but the name is also applied to D 433 in Porto Rico.)

Cerain.—Java, Kobus, Med. 6, 1893.

Cerane Geel.—Java, Kobus, Med. 6, 1893.

Cerane Soerat.—Java, Kobus, Med. 6, 1893.

Chaire.—India, Watt's Dict. 6(2):70.

Chalain.—Mauritius, Dept. Agr. Bull. 2:5, 1916.

Chalk Cane.— = Salangore, Deerr.

Chamar.—Mauritius, Duval, = Meera; Queensland, from Mauritius, Davidson, Easterby.

Chan, or Chann.—India, Watt's Dict. 6(2):66; The Sugar Cane 15:594 and 644, 1883. (More than one variety seems to be included); Barber Studies 1, =Katha.

Chapel Seedling.—Barbados, Rept. 1908–10:106, 1911.

Chareri.—India, Watt's Dict. 6(2):70.

Charkahiya.—India, Clark and Hadi, Agr. Inst. Pasa, Bull. 13, 1908.

Chelus No. 1.—Queensland, from Mauritius, Easterby, 1901.

Cheni.—Mysore, Coleman, Econ. Jour. 6 No. 4, Apr., 1920. "A hard, thin, drought-resistant, white cane; can be grown on alkaline soils; tillers freely and is a high yielder under good cultivation. Largely grown in areas with a precarious water supply as an 18-month cane. It is attacked by leaf fungi and smut but not by jackals and pigs."

Chenoma.—Queensland, from New Guinea, 1895, Maxwell, Easterby.

*Cheribon.—Name taken from a district in Java. It is used to include three color variants which constitute important commercial varieties. These are Black Cheribon, Morada, or Louisiana Purple; Light Cheribon, Crystalina, White Transparent or Rose Bamboo; and the Striped Cheribon, Rayada or Louisiana Ribbon. When used alone the name usually refers to Black Cheribon. Soltwedel, Fig. 2, represents a plant of Black Cheribon attacked by sereh. (See also Tjeribon.) In Australia Cheribon is used as = Cavengirie, usually the self-colored form.

Cheribon Koening.—Java, Wakker, 1896.

Cheribon Soerat.—Java, = Striped Cheribon.

Cherri.—India, Barber, Mem. 8(2), 1916; Mysore Agr. Calendar, 1915.

Chicaca.—Queensland, Easterby (see Chigaca).

Chicaga.—Queensland and Demerara (see Chigaca, Mauritius, Deerr, in lit. 5/25–21). "Still cultivated when I was there, more yellow than red, not Cavengirie."

Chief Branche.—Queensland, from Mauritius, 1878, Easterby.

Chigaca.—New Caledonia, Lavignac, 1870, The Sugar Cane 2; 674; Mauritius, from New Caledonia, 1869, Horne; Java, Wakker, 1896 (as Chijaaca); Queensland, from So. Sea Islands, 1874, Easterby; Demerara, Harrison and Jenman. A red cane (see Ti Chigaka).

Chikucha.—Florida and Georgia, from Formosa in 1911 as SPI No. 30464, P. A. Yoder. U. S. Dept. Agr. Cir. 392. Slightly susceptible to mosaic. Brandes and Klaphaak, one of the *Saccharum sinense* canes. Susceptible but tolerant to mosaic.

Childer's Zigzag.—Lyon, Hawaii Bull (Bot. 3(1); 41, 1921. Very resistant to Fiji disease.

Childs (RBC).—Haiti, Facts About Sugar, 1/16–26, p. 66. A local variety selected from a single stool, immune to mosaic.

Chimna Punda.—Bombay, India, Watt's Dict. 6(2): 74.

Chin.—North India, Barnes; United Provinces, Barber, Studies 3, = Chunnee.

China.—Straits Settlements, Wray, described as a small, very hard, yellow cane, quite distinct from Otaheite; India, Watt's Dict. 6(2): 49, quotes Roxburgh and Wray, = *Saccharum sinense* Roxb.; Java, from Malacca, Wakker, 1899; Natal, The Sugar Cane 9: 322, 1877; Demerara, Harrison and Jenmann, China II = Bourbon; Jamaica, the cane under this name seems to = Otaheite. Queensland, from Singapore, prior to 1880, Easterby, Bull. 2, 1926.

China Cane.—Noel Deerr (in lit. 1/1–21). "I found at Kew Roxburgh's own drawing of *Saccharum sinense* or the China Cane which was believed to have been lost."

* Dr. Jeswiet now distinguishes between the Cheribon and Preanger canes, which were considered synonymous by all earlier writers. Louisiana Purple, Louisiana Ribbon, and Crystalina all seem to belong in the Preanger series.

Chine N(atal).—Mauritius, from Natal, Boname, 1896 and 1898–9.

Chine P(amplemousse).—Mauritius, Boname, 1896 and 1898–9. Considered distinct from the last.

Chinese.—Queensland, 1880, Davidson, = China (of Wray), Otaheite (of Queensland Bot. Gar.) Creole (West Indies). Davidson's description agrees with that of Wray for China. The "very upright, pale green leaves" would apply to Creole, but "cane itch plentiful" does not. Evidently Creole does not belong here.

Chinese Canes.—Brandes and Klaphaak, Breeding Disease-resistant Sugar Plants, 1925. These constitute the Pansahi group by Barber. They are considered a distinct species by Jeswiet (= *Saccharum sinense* Roxburgh). In the United States we now have the following varieties: *Uba, *Cayania, Tekcha, Yon-ton-san, *Kavangire, *Oshima, Khera, Merthi, *Kinar, Kikaigashima, Chikucha, Chikusho, *Zwinga and *Japanese. Those marked with * are considered immune to mosaic. The others are susceptible but remarkably tolerant. (P. A. Yoder, U. S. Dept. Cir. 392, claims that all of these varieties are occasionally attacked by mosaic.) As a group they are very tolerant of root disease but are subject to smut and red rot. Not native in North India but constitute a considerable proportion of the canes grown in India, China, Japan, Formosa, Natal, and lately Porto Rico. They all stool prolifically and ratoon for long periods. The pollen is usually degenerate, so it is difficult to secure self-fertilized seedlings, but hybrids are easily obtained.

Chini.—Madras, India, Noel Deerr (in lit. Jan., 1921). This is distinct from Chunnee of the north. It is of the Uba type and may be the *Saccharum sinense* Roxburgh.

Chinia.—Behar, India, Int. Sug. Jour., Oct., 1925, p. 532. Belongs to the Pansahi group and is close to Uba. Extensively planted in low-lying land. Noel Deerr (in lit. 1/29–25). This is the original of *Saccharum sinense* Roxburgh. It is much like Uba if not identical with it.

Chinkha.—India, Watt's Dict. 6(2) : 66.

Chinya.—India, Sabour, Taylor.

Chitta Rastali.—Mysore, Coleman, Econ. Jour. 6(4), Apr., 1920. A thinner variety than Rastali but of the same general character.

Chittan.—India, Barber Studies 2, a striped cane.

Chittuwanum.—Madras, India, Watt's Dict. 6(2) : 76.

Chitu.—Nepal, India, Watt's Dict. 6(2) : 66, = Sanno-Gheura.

Chuk-che.—Listed as in the Arlington Greenhouses, U. S. Dept. Agr. (in lit. 6/21–26).

Chun.—India, North West Prov., Watt's Dict. 6(2) : 62 and 67.

Chunnee.—Java, from English India, Kobus, Med. 48, 1893. Brought by Kobus in 1890, Van Denventer, Handb. 5, 141. The male parent used by Kobus in his crossings which are listed under POJ with numbers. India, Barber, Studies I, = Chin; United Provinces, Barber, Studies 3.

Deerr suggests (in lit. 5/25–21) perhaps etymologically = China, Brandes and Klaphaak, Breeding for Resistance in Sugar Plants, of the Saretha group. It and all of its seedlings so far tested are susceptible to mosaic but are very little injured by it. They are very tolerant of frost and this character is frequently transmitted to hybrids (= *Saccharum Barberi* Jesweit).

Chyaca.—Jamaica, from Mauritius, 1882, Sir D. Morris (see Chigaca).

Chynia.—India, Barber, Woodhouse (see Chinia).

Cima.—Queensland, from Java, 1874, Easterby.

Cinzenta.—Brazil, Deerr, = Grossona.

Claret Cane.—Jamaica, MacFadyen. See Violet Cane (= Dark Preanger) Java, from Malacca, Wakker, 1896.

Clark's Seedling.—Australia, Int. Sug. Jour., June, 1925, p. 299 = H 1 426, North, Control Cane Diseases, p. 26.

Cleland Seedling.—Barbados, Rept. 1908–10, 78, 1911.

Cochin China.—Java, Kobus, 1893.

Coimbatore Seedlings.—(As CO. with numbers). A series of cross-bred seedlings propagated by C. A. Barber at the Coimbatore Cane Experiment Station in India. Many of them are crosses of the POJ canes on native Indian kinds. They are being planted extensively in India, especially CO 205, 210, and 213. See Int. Sug. Jour., May, 1923, p. 242. Are also attracting attention in other countries because of hardiness and drought-resistance. All seem to be susceptible but tolerant to mosaic.

Coki.—Queensland, from Singapore, 1880, Easterby.

Collyns.—Babados, Rept. 1905–7: 23, 1908; Rept. 1908–10: 17, 1911. Lousiana, Agee, 1911.

Colony.—Demerara, Harrison and Jenman, = Bourbon.

Common Green.—Erwin F. Smith, Bacteria 3: 69, susceptible to gum disease; Georgia, = Otaheite, Yoder.

Common Red.—Trinidad, Williams, Bull. 18: 74, 1819, = Congo Red (= Cavengirie).

Congo Red.—Trinidad (see Common Red).

Corra Corra.—Queensland, 1878. Country of origin not known, Easterby.

Country Cane.—Jamaica, MacFadyen, 1830, (= Creole).

Couve.—(With number): Queensland, from Mauritius, 1901, Easterby; Louisiana.

Crede.—Demerara, The Sugar Cane 29: 414, 1897 (a misprint, see Creole).

Creole.—Florida and Louisiana, Stillman, 1833, Flieshman, 1848; Demerara, Harrison; Queensland, from West Indies, 1878, Easterby, = Brazilian, Porter; = Country Cane, MacFadyen, Jamaica; = Ribbon Cane, Argentina (see Maval Pundia), = Puri, Deerr.

Criolla.—Porto Rico, Stahl, Lopez Tuero; Argentina, Schleh (= Creole).

Criolla Blanca.—Argentina, Fawcet, 1919, = Crystalina.

Criolla Morada.—Argentina, Fawcett, 1919, = Louisiana Purple, Morada Egypcia (= Black Cheribon).

Criolla Rayada.—Argentina, Fawcett, 1919, = Louisiana Ribbon, Egypcia Rayada, Ravanais (= Striped Cheribon).

Crioula.—Brazil, E. F. Smith, Argentina, from Brazil, Zerban (= Creole).

Crystalina (Also written Cristalina).—The common Latin-American name for Light Preanger, the most widely planted commercial cane. According to Stubbs = Bourbon from Trinidad, Green from Cuba, Hope from Jamaica, La Pice, Le Sassier, Light Java, Panache, and Tebboo Merd. According to Deerr = Blue, Burk, Green, Hope, La Pice, Le Sassier, Light Java, Mexican Bamboo, Mamuri, Mont Blanc, Naga B., Panachee, Rappoh, Rose Bamboo, Tibboo Merd, White Cheribon, White Transparent, Yellow Singapore, and Yellow Violet.

Cuapa.—Jamaica, from Mauritius, 1882, Sir D. Morris; Louisiana, from Jamaica, Stubbs, Agee.

Cuba.—Frequently met in the literature, usually = Otaheite.

Cullerah.—India, Papers—Sugar, etc., 1822. Mentioned in 1792 as growing in swampy land.

Culleroah.—India, Deerr = Bamboo, Deerr (in lit. 5/25–21) = Kulloa, Kullore, Kajoole, and Kadjuli (see also Kullerah).

Cutamotee.—Queensland, Davidson, 1880. The description indicates = Cavengerie.

Cutarrah Red.—Mauritius, from India, 1869, Horne.

Cutarrah White.—Mauritius, from India, 1869, Horne.

Cuttay Cabo.—India, Papers—Sugar, etc., 1822; Madras Watt's Dict. 6(2):76.

Cyana.—Brazil, = Cayania (= Otaheite).

D.—(As initials with numbers): Demerara Seedling.

Dacca Gandari.—Bengal, India, Agr. Inst. Pusa. Bull. 83; 27, 1919.

Dadap Pasien.—Java, from Sumatra, Wakker, 1896.

Daimokko Striped.—Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920.

Dama.—Demerara, Harrison and Jenman, Java, from Malacca, Wakker, 1896. The name seems to have originated in Demerara (see Daura, Dooma, and Dora).

Daniel Dupont.—Queensland, from Mauritius, 1878, Easterby; Java, from Australia, Wakker, 1896. Resists gum disease, E. F. Smith, Bact. 3:69. Very susceptible to Fiji disease and badly stunted by it in Fiji, Lyon, Hand. Bull. (Bot.) 3(1), Aug., 1921 (= Striped Tip, Hawaii, Moir).

Dantur.—India, Watt's Dict. 6(2):62.

Dark Colored Bamboo.—Hawaii, Eckert, Bull. 10:9, 1905, = Black Cheribon, Deerr.

Dark Purple (or Red Blouguet).—Australia, from Isle of Bourbon, 1857, Monmouth Hall, The Sugar Cane, 6:588 (= Black Cheribon).

Dark Red Striped.—Java, from Malacca, Wakker, 1896.

Dark with Red Lines.—Brazil, The Sugar Cane 22:183, 1890 (= Cavengirie).

D'Aryeli.—Haiti, Tussac, 162, 1808.

Das Kabbu.—Bombay, India, Watt's Dict. 6(2):73.

Daula.—India, Watt's Dict. 6(2):66.

Daura.—Jamaica, from Mauritius, 1872, Sir D. Morris (see Dama and Dooma).

Davonboota.—Java, from Malacca, Wakker, 1896.

Deci.—Java, from British India, Kobus, Med. 48, 1893.

Degehin.—Java, from British India, Kobus, Med. 48, 1893.

Degenerada de Quissman.—Brazil, Moreira, 1876.

Delenole.—New Caledonia, Vieillard, 1863, Sagot, 346.

Delon.—New Caledonia, Vieillard, 1863, Sagot, 347.

Demak Idjo.—(Seedlings with numbers): Java, the result of crosses on Black Cheribon made by P. J. Stock in 1903, Jeswiet, Med. 5, 1918.

Demarara.— = Meligeli, Harrison and Jenman, = Bamboo I and III. Deerr.

Desavali.—Madras, India, Int. Sug. Jour., 2:471, 1900.

Desi.—India, Watt's Dict. 6(2):67.

Desi Suretha.—North India, Barnes.

Desivari.—Madras, India, Int. Sug. Jour., 2:469, 1900.

Devagadi.—Bombay, India, Knight, = Sannabile.

Dhali Surang Langli.—Assam, Stack, 1883, Watt's Dict. 6(2):62.

Dhalsunder.—Bengal, India, Watt's Dict. 6(2):60, Sabur, Taylor, Woodhouse.

Dhani.—India, N. W. Provinces, Watt's Dict. 6(2):62.

Dhaori.—India, Watt's Dict. 6(2):67.

Dhaulu.—India, Barber, Studies, 1, 2, 3; North India, Barnes, Watt's Dict. 6(2):67, also as Dowlo (= Sahranpuri).

Dhaulu of Bham.—North India, Barnes.

Dhaulu of Phillaur.—India, Barber, Studies, I.

Dhaunr.—India, N. W. Prov., Watt's Dict. 6(2):62.

Dhaura Kanar.—North India, Barnes.

Dhaura of Azamgarh.—India, Pusa, Clark and Hadi; North India, Barnes. A thick cane.

Dhola.—India, Watt's Dict. 6(2):70.

Dhor.—India, Cent. Prov., Barber, Studies, 3.

Dhori.—India, Watt's Dict. 6(2):70.

Dhour.—Java, from British India, Kobus, Med. 48, 1893.

Dhoura.—North India, Barnes.

Dhur.—Cent. India, Watt's Dict. 6(2):69.

DI.—(Initials with numbers): See Demak Idjo.

Diamond.—(With numbers): Refers to seedlings grown at the Diamond Plantation in British Guiana.

Diard.—Mauritius, from Java, 1850, Dept. Agr. Bull. 2:5, 11, 1916; Queensland, from Mauritius, 1870, J. Hill; Java from Malacca, Wakker, 1896; Porto Rico, Stahl 1880, Lopez Tuero, who notes several kinds of Diard. = Black Cheribon, Deerr. Named for the man who sent these canes from Java to Réunion and Mauritius at the time of the first disease outbreak. The name seems to be used as equal to Cheribon and to include the three color forms.

Diard Rayee.— = Striped Cheribon, Deerr.

Diard Rose.—Queensland, from Mauritius, Easterby.

Dikchan.—India, N. W. Prov., Watt's Dict. 6(2): 62.

Divisao.—Pernambuco, Brazil, Bull. 3, = Canna de Beija Flor, = Roxa.

Djahara.—Java, Vanderventer, Handb. 5:134, 1915 (see Japara).

Djamprik.—Java, from Java, Wakker, 1896. Soltwedel, Fig. 16. The plate represents a slender, dark-purple cane with surface cracking, nodes not constructed, cylindrical, buds large, ovate. One is developed into a leafy shoot to show the purplish leaves. Argentina, = Vinagre de Sao. Simao, (= Etam Obat, Manulele), = *Saccharum violacum nigrum*, Bouton, 1863, = Canne Mozambique.

Djandjan.—Java, from Borneo, Wakker, 1896.

Djawa.—Java, from Sumatra, Wakker, 1896.

Djoeng Djoeng.—Mauritius, from Java, 1869, Horne, Striped. Queensland, from Java, Davidson, 1880, = Green Ribbon (spelled Djioeng Djioeng). Susceptible to gum disease, E. F. Smith. Java, from Sumatra, Wakker, 1896.

Djogoeng.—Java, from Sumatra, Wakker, 1896.

Djomba-Coure.—New Caledonia, Breslan, 1884, Sagot, 332.

Djong-Djong.—Queensland from Java, Arc. 1. Ap. 1892 (see Djoeng Djoeng); Java from Australia, Wakker, 1896.

Djoombakomay.—Java, from New Caledonia, Wakker, 1896.

Dogangueni.—New Caledonia, Vieillard, 1863, Sagot, 348.

Dolhu.—Java, from British India, Kobus, Med. 48, 1893.

Domo.—New Caledonia, Breslau, 1884, Sagot, 340.

Don Caetona.—Argentina, from Brazil, Zerban, 1910.

Dooma.—Queensland, from Fiji, 1878, Easterby.

Do-omo.—Mauritius, from New Caledonia, Lavignac, 1870, Horne.

Dora Batu.—Queensland, from Fiji, 1878, Easterby.

Dora Kaili.—Queensland, from Fiji, 1878, Easterby.

Dora Kenta.—Queensland, from Fiji, 1878, Easterby.

Dora Le Muri.—Queensland, from Fiji, prior to 1878, Easterby, Bull. 2, 1926.

Dora LuLu.—Queensland, from Fiji, 1878, Easterby.

Dora Mai Mai.—Queensland, from Fiji, 1878, Easterby.

Dora Siga.—Queensland, from Fiji, 1878, Easterby.

Dora Tamati.—Queensland, from Fiji, 1878, Easterby.

Dora Vies.—Queensland, from Fiji, 1878, Easterby.

Dora Von Von.—Queensland, from Fiji, 1878, Easterby.

Douwn Merah.—Java, from Hawaii, Wakker, 1896.

Dowlo.—India, Watt's Dict. 6(2):67 (see Dhaulu).

Dr. Caetano.—Bahia, Brazil, The Sugar Cane, 22:483, 1890 (see Don Caetona).

Dyer.—Demerara, introduced from Barbados in 1889 as an inadvertent mixture with Morris (Sir John Harrison, in lit. 9/26–23). "The most striking cane introduced in 1889. It fills the eye of the planter but, so far as ascertained, this is its only merit. D 625 is a seedling from it raised in 1892."

Egg Cane.—Wray, see Tibboo Teelor.

Egypcia Ambar.—Argentina, Tuc. Rev. 5(5):209, 1914 (see Java, 105 POJ).

Egypcia Morada.—Argentina, Rev. 5:209, 1914, = Louisiana Purple, Rev. 9:130.

Egypcia Rayada.—Argentina, Rev. 5:209, 1914, = Louisiana Ribbon, Rev. 9:130 (= Striped Preanger).

Egyptian.—Mauritius, from Egypt, Horne, 1869; Jamaica, Sir D. Morris. The Sugar Cane 17:153, 1885, Dark Purple, adapted for dry regions, Jamaica, Bot. Dept. Bull. 2 from Mauritius in 1882, striped green (evidently a mixture under this name in Jamaica).

Egyptian Striped.—Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920.

Eikur.—India, Watt's Dict. 6(2):67.

EK.—(As initials with numbers): Java, Seedlings grown by E. Karthaus by crossing Fidji as staminate on Bandjermassing Hitan or Borneo as Pistillate, Jeswiet, Med. 8, 1917. (EK 28 is the principal commercial cane of Java and is the parent of POJ 2714, 2725, and 2878.)

Ekar.—India, Watt's Dict. 6(2):66; Barber, Studies, 2 and 3, also The Sugar Cane 15:594 and 644, 1883.

Elephant.—Annam, Cochin China, = Mia Voi, The Sugar Cane, 11:118, 1869, Mysore, Agr. Col., 1915; Hawaii, Deerr and Eckert; Demerara, Harrison and Jenman, from Jamaica, noted as quite distinct from the true Elephant; Jamaica, Bot. Bull. 2; Guadeloupe, The Sugar Cane, 4:274, 605, 1872; Queensland, from Mauritius, 1878, Easterby, = Teboe Gladjah, Deerr.

Elephante.—Porto Rico, Lopez Tuero, = Gigante.

Ensertada or Junction.—Brazil, The Sugar Cane, 25:187, 1893 (a supposed graft-hybrid).

Envernizada.—Brazil, = Manteiga, Deerr.

Escambine.—(With numbers): Queensland, from Mauritius, 1901, Easterby (see Iscambine).

Escossia Sao Simao.—Argentina, from Brazil, Zerban, 1910.

Esimbic.—Louisiana, from Jamaica, Agee (see Tsimbic).

Española.—Argentina, from Brazil, Zerban, 1910 (see Creole).

Etam (Tebboo Etam).—Straits Settlements, Wray; Queensland, from Batavia, 1878, Easterby, = Black Cheribon, Deerr. The word Etam, Etem, Hetem, or Hetam, as it is variously spelled, a Malay word meaning black, occurs in many cane names.

Etam Obat.—Medicine Cane, Wray, leaves purple (= Djamprik).

F.—(As initial following numbers): = Fabri, Ledebour, Med. 4: 452, 1917.

FACC.—(As initials with numbers): Barbados, Rept. 1917–19: 60, 1919, no explanation.

Fairymead.—Queensland, Easterby, = D 1135.

Fary-Ahomber.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Andrafaw.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Baymayvow.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Boubaya.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Carang.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Corowh.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Feesweet.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Maeritee.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Mang-Indavalan.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

Fary-Voulon.—Madagascar, sent to Mauritius Bot. Gar. in 1813–16, Thompson (see Watt's Dict. 6(2): 41–8).

FC.—(As initials with numbers): Porto Rico, Fajardo Central seedlings.

Ferrea.—Argentina, from Brazil, Zerban, 1910, = Cavengirie, Deerr.

Fiambo.—Mauritius, Rept. 1896; Argentina, from Brazil, Zerban, 1910 (see Tsiambo and Tiambo).

Fiji.—Java, (also spelled Fidji and Fidsji), = Canne Mort, immune to sereh. Used by Bruicius and others in making crosses. Frequently mentioned, especially in Java literature.

Fiji B.—India, Barber, Studies 2.

Fiji Bamboe.—Java, Kobus, Med. 6, 1893.

Fiji Geel.—Java, Kobus, Med. 6, 1893.

Fiji Geel Gestreipt.—Java, Kobus, Med. 6, 1893.

Fiji Koening.—Java, Moquette, Arch. 6: 301, 1898, = Canne Mort.

Fiji Rayée.—Mauritius, Boname, Rept. 1895, 1896; badly attacked by gum disease, 1898–9.

Fiji Ribbon.—Australia, Melmouth Hall, The Sugar Cane, 6:588, 1874.
Fiji Zwart Gestreipt.—Java, Kobus, Med. 6, 1893.
Fistula de Sao Simao.—Argentina, from Brazil, Zerban, 1910. See Morada del Pais (= Dark Preanger).
FJC.—(Initials with numbers): Barbados, Rept. 1917–19:60, 1919.
Flor de Brazil.—Brazil, Gorkum, 1915.
Flor de Cuba.—Brazil, = Manteiga, Deerr.
Formosa.—Philippines, Agr. Rev. 6:618, 1913, = Rose Bambou, Mendiola, Identification Key, Sugar Cane Varieties, Plant News. 3(1). Jan., 1922.
Foster's Seedling.—Trinidad, Bull. 18:73, 1919.
Fotiogo.—Mauritius, Boname, Rept. 1895; Agr. Bull. 2:5, 1916. Introduced from New Caledonia about 1870; So. Africa, from Mauritius, Choles.
Fraser.—Mauritius, Boname, Rept. 1898–9.
Frijoe.—Java, from Borneo, Wakker, 1896; West Java, Geerligs, Med. 27.
Frost Resister.—Australia, Easterby, = D 1135.
Fudburi.—Bombay, India, Knight, = Phusburi.
Funcion.—Bahia, Brazil, The Sugar Cane, 22:83, 1890.

Gabrasdali.—Bombay, India, Watt's Dict. 6(2):72.
Gadenadeboni.—New Caledonia, Vieillard, 1863, Sagot, 346.
Gading.—Java, Borneo, Sumatra, Wakker, 1896.
Gadjah.—Java, from Java, Malacca, Wakker, 1896; Soltwedel, Fig. 7, represents a stout green cane much blackened by sooty mould, internodes medium short, enlarged above, not staggered, nodes prominent, buds ovate, divergent, = Elephant, Deerr.
Gadmghetoel.—Java, from Borneo, Wakker, 1896.
Gagak.—Java from Sumatra, Wakker, 1896, Kobus, 1893.
Galaga.—(With numbers): Queensland, from Mauritius, 1901, Easterby.
Galaga C.—Mauritius, Boname, Rept. 1895, 1898–9.
Galaga M.—Mauritius, Boname, Rept. 1895, 1898–9.
Galoengoeng.—Java, from Sumatra, Wakker, 1896.
Galogo C.—Queensland, from Mauritius, 1902, Easterby, Maxwell, Rept. 1903–4 (see Galaga).
Ganda Cheni.—Maysore, Barber, Studies, 3.
Ganna.—India, a class name, among the older writers, S. M. Hadi, Deerr (see Int. Sug. Jour., Jan., 1918).
Garei.—Java, from Sumatra, Wakker, 1896.
Garig.—Queensland, from Louisiana, 1895, Easterby; Louisiana, Stubbs, a dark-striped bud sport.
Garvan's Black.—Queensland, from N. S. Wales, Bengara Plantation, Easterby, Bull. 2, 1926.
Garvar.—Java, from Borneo, Wakker, 1896.

GC.—(As initials with numbers): Porto Rico, seedlings grown at Central Guanica; Barbados, Rept. 1911–13: 57, 1913, doubtless also refers to these Guanica Seedlings.

Gee Gow.—Hawaii, Eckert, Bull 10: 7, 1905.

Geel.—Java, from Manila, Wakker, 1896.

Geel Duitsch N. Guinea.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911.

Geel Gestreipt Batjan.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911.

Geel Muntok.—Java, Geerligs, Med. West Java, 27.

Geel Shamshara.—Java, from Calcutta, Kobus, Med. 48, 1893 (= Otaheite).

Gending Soerat.—Java, Kobus, Med. 6, 1863.

Generatie.—Queensland, from Java, 1916, = Java, 247, Easterby, Bull. 2, 1926.

Geolo Mila.—Queensland, from Fiji, 1878, Easterby.

Gestreipt Cheribon.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911 (see Striped Cheribon).

Gestreipt Fidji.—Java, Geerligs, West Java, Med. 27.

Gestreipt Mappoe.—Java, Geerligs, West Java, Med. 27.

Gestreipt Muntok.—Java, Harreveld, Med. 13: 216, 1918.

Gestreipt Preanger.—Java, Harreveld, Van Derventer, Handb. 5: 145, 1915 (= Louisiana Ribbon).

Ghewora-tu.—India, Watt's Dict. 6(2): 66.

Ghorru.—India, Watt's Dict. 6(2): 67.

Gigante.—Porto Rico, Stahl, Rev. de Agr. 1174, 1887; Lopez Tuero, = Elefante.

Gingan.—Queensland, from Singapore, prior to 1880, Easterby, Bull. 2, 1926.

Gingham.—Mauritius, Queensland (see Guingham).

Gingila.—Queensland, Easterby, a supposed graft-cross between Mauritius Guingham and Badila.

Gingor.—Queensland, Easterby, a supposed graft-cross between Mauritius Guingham and Goru.

Gingoya.—Queensland, Easterby, a supposed graft-cross between Mauritius Guingham and Oraya.

Gitana.—Porto Rico, Manuel del Valle (in lit. 3/15–23).

Glagah.—Java, from Java, Wakker, 1896; Teboe Glagah, Soltwedel, Fig. 27. A slender grass-like green cane, the wild *Saccharum spontaneum* of Java, immune to sereh, E. F. Smith, Bact. 3: 76.

Glonggong.—Java, from Java, Wakker, 1896; Teboe Glonggong, Soltwedel, Fig. 26, represents a slender green, reed-like cane, with only one row of rudimentary roots, = *Saccharum Soltwedeli*, Kobus, Arch. 1: 17, 1893. Immune to sereh, E. F. Smith, Bact. 3: 76.

Gloreale.—New Caledonia, Vieillard, 1863, Sagot, 345.

Goat Shank.—Jamaica (see Selangore).

Goela.—Java, from Sumatra, Wakker, 1896. Teboe Goela, Soltwedel, Fig. 1, represents an entire stool of cane, so no details given. It is a dark,

reddish-purple, erect cane resembling Cavengirie. The text suggests that it may be the same as Teboe Gagak.

Gogari.—Queensland, from New Guinea, as No. 8A Maxwell, Easterby, Deerr.

Goi Goi.—Queensland, from New Guinea, as No. 42, Easterby, called Palmyra in the Mackay district. Introduced in 1896.

Goja.—Java, from Sumatra, Wakker, 1896.

Gold Dust.—So. Africa, Choles (see Pulvo de Oro).

Gondang.—Java, from Sumatra, Wakker, 1896.

Gonzalves.—Java, = Black Cheribon, Deerr.

Goru.—Queensland, from New Guinea, as No. 24, 1896, Easterby.

Goru Bunu Bunana.—Queensland, from New Guinea, No. 246, Easterby, Maxwell; Mauritius, from Queensland, Bull. 22, 1910.

Goru Green.—Queensland, a standard kind in Mackay district, Int. Sug. Jour., June, 1923, p. 291, = Goru Bunu Bunana, both N. G. 246.

Goru Possi Possana.—Queensland, from New Guinea, as No. 24, Maxwell, Easterby, Deerr; Mauritius, from Queensland, Bull. 22, 1896. (It seems to = Goru since both are based on Tryon's N. G. 24.)

Goru Seela Seelana.—Queensland, from New Guinea, as No. 24A, Maxwell Deer; Mauritius, from Queensland, Bull. 22, 1910.

Governo de Sao Simao.—Argentina, from Brazil, Zerban, 1910.

Governor.—Jamaica, Sug. Sta. Rept. 2: 62, 1908.

Governor Lees.—Demerara, Harrison and Jenman.

Graine Ch. Blanche.—Mauritius, Boname, Rept. 1898–9.

Graine Ch. Rouge.—Mauritius, Boname, Rept. 1898–9.

Graine Rouge.—Mauritius, Boname, Rept. 1898–9.

Grande Savanne.—Jamaica, from Mauritius, 1882, Sir D. Morris; Demerara, Harrison and Jenman; Louisiana, from Jamaica, Stubbs, Agee. (The name seems to have originated in Jamaica.)

Grankay.—Queensland, from Mauritius, 1878, Easterby.

Grassy Black.—Bombay, India, Knight, Bull. 61, 1914.

Gray Fiji.—Australia, from Fiji, 1866, by O. O. Danger, Melmouth Hall, The Sugar Cane, 6: 588, 1874.

Green.—Louisiana, = Crystalina, Stubbs, Deerr.

Green and Yellow.—Java, from Malacca, Wakker, 1896; Queensland, from Mauritius, 1878, Easterby.

Green Bamboo.—Queensland, from Mauritius, 1878, Easterby.

Green Brisbane.—Jamaica, from Mauritius, 1882, Sir D. Morris (see Green or Yellow).

Green Cane.—Georgia, Florida, = Otaheite, Yoder, U. S. Dept. Agr. Bull. 486.

Green Diard.—Queensland, from Mauritius, Davidson, 1880, "cane itch strong." (The Diard Canes usually = Cheribon, but this cannot be one of them.)

Green Dupont.—Queensland, 1878, Easterby, a supposed sport from Daniel Dupont, resistant to gum disease, E. F. Smith, Bact. 3: 69.

Green Elephant.—Louisiana, from Jamaica, Stubbs, Agee.

Green Natal.—So. Africa, Choles, = Umoba, H. H. Storey, = Rose Bamboo, Cheribon Series, susceptible to both streak disease and mosaic, Rept. Imp. Bot. Congress: 137, 1924.

Green or Yellow.—Australia, Brisbane Bot. Gar., 1870, from New Caledonia, The Sugar Cane 2: 104, 1870 (see Green Brisbane).

Green Ribbon.—Louisiana, Fleishman, 1848, with colored plates; Georgia, Florida, = Simpson, Yoder; Queensland, = Djoeng Djoeng, Davidson; Demerara, = Malay, Brisbane, Harrison and Jenman; = Green Rose Ribbon, Deerr (= Calancana, Imperial de Brazil, a white striped sport of Otaheite).

Green Rose Ribbon.—Jamaica, from Mauritius, 1882, D. Morris; Louisiana, from Jamaica, = Malay, Brisbane, Stubbs, = Green Ribbon, Malay, Brisbane, white striped Bourbon, Louzier Rayee, a striped sport from Otaheite, Deerr. (This name seems to have originated in Jamaica.)

Green Salangore.—Trinidad, a provisional name proposed by Mr. Purdie, The Sugar Cane, 11: 585, 1879.

Green Striped.—Louisiana, from Jamaica, Agee (= Green Ribbon).

Green Striped Borneo.—Deerr, 55.

Green Striped Lousier.—Mauritius, as a sport from Lousier, Dept. Agr. Bull. 2: 11, 1916 (= Green Ribbon).

Green Tanna.—Queensland, from Mauritius, in 1878, = Malabar, Easterby; Mauritius, from N. S. Wales, 1895, = White Tanna. Dept. Agr. Bull. 2: 11, 1916 (= Yellow Caledonia).

Green Transparent.—Demerara, West Ind. Bull. 5: 344, 1905, = Salangor, Deerr.

Greet.—Java, from Sumatra, Wakker, 1896.

Groen(dun).—Java, from Dutch New Guinea, Wakker, 1896.

Groen Batjan.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911.

Groen Duitsch N. Guinea.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911.

Grosse Blanche.—Mauritius, Boname, Rept. 1895, 1898–9.

Grosse Verte de Taiti.—Jamaica, Tussac, 1808, Pl. 25, Fig. 1. The plate represents a green, strongly zigzag or staggered jointed cane, about 1⅛ inches in diameter, nodes prominent, rudimentary roots large, in three rows, glaucous band well marked, growth ring broad, whitish.

Grosse Violette de Taiti.—Jamaica, Tussac, 1808, Pl. 25, Fig. 3. The plate probably represents Black Cheribon, but if so the drawing is not good and the diameter is too great as compared with Otaheite which is also figured. Deerr (in lit. 5/25–21) expresses the opinion that this plate does not represent Black Cheribon but some other kind that seems to have been lost.

Grossona.—Brazil (see Cinjenta) Deerr.

Gros Ventri.—Queensland, from Mauritius, 1878, Easterby.

GTC.—(As initials with numbers): Barbados, Rept. 1917–19: 60.
Guana Cane.—(Guiana) Mauritius (see Jamaica Cane) 1869, Horne.
Gubbi Rasdala.—Bombay, India, Knight (see Punda).
Guinabhi.—Mauritius, from New Caledonia (Lavignac), 1869, Horne.
Guiname.—Mauritius, from New Caledonia (Lavignac), 1869, Horne.
Guinapa.—Queensland, from So. Sea Islands, 1874, Easterby.
Guinapassa.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.
Guingan.—Porto Rico, Stahl, 1880 (see Guingham).
Guingham.—Porto Rico, Lopez Tuero; Queensland, from Mauritius, prior to 1874, Easterby, Bull. 2, 1926, = Big Ribbon, = Striped Tanna, Deerr (see also Gingham and Guinham). This name has often also been applied to Striped Preanger.
Gulisan.—Philippines, Mendiola, Identification Key, Plant News 3(1), Jan., 1922, F. J. Gamboa (in lit. 8/26–25), white with green stripes.
Gundgire.—India, Watt's Dict. 6(2): 72.
Guro.—Philippines (see Goru).
Guyane.—Mauritius, Horne, 1869 (Cayane?).
GZ.—(Initials with numbers): Java, = Zaadriet Generation, = Seedling. In the Java literature it is often used before numbers, with POJ, B, or other letters following. Simply the old idea that "seedling canes" are something different and apart from the old named kinds.

H.—(As initial with numbers): Seedlings grown in Hawaii.
Haak Kwat Che.—Given in a list of canes in the U. S. Dept. Agr. greenhouse at Washington, 6/21–26.
Habenera.—Mexico (see Caña Violeta de Batavia, = Djamprik).
Haboel.—Java, from Sumatra, Wakker, 1896.
Hambledon.—Argentina from Queensland, as No. 426, Rev. Tucuman, 9(1): 14, 1918; Philippines, Mendiola, Identification Key, Plant News 3(1), Jan., 1922, = Luzon 4.
Hanara.—India, Watt's Dict. 6(2): 66.
Hanau.—Java, from Riouw, Wakker, 1896.
Hannays No. 2.—Barbados, Rept. 1907–9: 87.
Hapoei.—Java, from Sumatra, Wakker, 1896.
Hard Red.—Bombay, India, Knight, Bull. 61, 1914, = Songada Kati.
Hard Striped.—Bombay, India, Knight, Bull. 61, 1914, = Bangadya.
Harong.—Java, from Sumatra, Wakker, 1896.
Harrison.—Demerara, Harrison and Jenman.
Haruki.—Behar, India, of the Nagori group, semi-aquatic, Int. Sug. Jour., Oct., 1925, p. 532, and Feb., 1925, p. 81.
Hatch.—Queensland, from Java, 1878, Easterby.
Hatthoni (or Hatthooni).—Behar, India, of the Nagori group, semi-aquatic, Int. Sug. Jour., Feb., 1925, p. 81 and Oct., 1925, p. 532.
Hauer.—Mauritius, from Java, Horne, 1869; Queensland, from Java, 1874, Easterby.

Hauer Mheera.—Mauritius, from Java, Horne, 1869.

Haw.—(With numbers): Barbados, Rept. 1913–15: 55.

Hawaii.—Philippines, Mendiola, Identification Key, Plant News 8(1), Jan., 1922. (Not clear which Hawiian cane intended.)

Hawe.—Java, from Sumatra, Wakker, 1896.

Hemja.—India, Taylor, Woodhouse, Clark and Hadi; Behar, India, Int. Sug. Jour., Vol. 13, a dwarf cane, ripens late, Int. Sug. Jour., Sept., 1921, p. 557, the kind chiefly grown, Int. Sug. Jour., Oct., 1925, p. 532, a cane of the Mungo group.

Heywood's Seedlings.—Barbados, Rept. 1905–7: 36, 1808.

Hillii.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison and Jenman.

Hill's Seedling.—Trinidad, Bull. 18: 37, 1919.

Hind's Special.—Philippines, Sugar News, Oct., 1925, p. 599; Sugar News 6(10): 599–601, 1925, a native cane brought down from the Zambales Mts., apparently immune to smut and mosaic.

Hitam.—Java, from Sumatra, Wakker, 1896. (Hitam also written Hitem, Itam, Item, and Hitan, meaning black.)

Hitam Broewang.—Java, from Borneo, Wakker, 1896.

Hitam Kalampi.—Java, from Borneo, Wakker, 1896.

Hitam Siam.—Java, from Borneo, Wakker, 1896.

Hitan.—Queensland, from New Guinea, as No. 41, 1896, Easterby (see Hitam).

Hitem.—Java, from Sumatra, Wakker, 1896.

Hitem Dadak.—Java, from Borneo, Wakker, 1896 (see Tibu Item Borneo, Kruger (see Black Borneo).

HM.—(With numbers): Seedlings grown in Mysore India, Int. Sug. Jour., May, 1923, p. 245.

Hoeloe.—Java, from Sumatra, Wakker, 1896.

Home Purple.—Louisiana; Queensland, from Louisiana, 1895, Easterby, = Louisiana Purple.

Home Ribbon.—Louisiana, = Red Ribbon Stubbs, = Striped Cheribon, Deerr [Striped Preanger].

Home Striped.—Queensland, from Louisiana, 1895, Easterby, = Louisiana Ribbon.

Honderdbruin.—Java, = 100 B, Harreveld, Med. 15: 1597, 1917.

Honduras.—Argentina, from Brazil, Zerban, 1910.

Hong Kong Soerat.—Java, Kobus, Med. 6, 1893.

Honolulu.—Demerara, Harrison and Jenman.

Honuaula.—Hawaii, Eckert, Bull. 17: 9, 1906; Louisiana, from Hawaii, Stubbs, = Ohia, = Papaa.

Hope.—Jamaica, Bot. Bull. 2; Louisiana, from Jamaica, = Crystalina, Stubbs.

Horne.—Jamaica, from Mauritius, 1892, D. Morris; Demerara, Harrison and Jenman; Louisiana, from Jamaica, Stubbs, 1896; Mauritius, =

Louzier Rayée, a striped sport from Louzier, Deerr. (A red-striped form of Otaheite?)

Hotte Cheni.—Mysore, India, Barber, Studies, 3.

HQ.—(As initials with numbers): Queensland, seedlings grown at the Hambledon Estate by the Colonial Sug. Ref. Co., 1901 to 1905. After this date their seedling work was transferred to Fiji, Easterby.

Hullu.—Madras, India, Barber, Studies, 3.

Hullu Kabbu.—India, Barber, Studies, 2.

Hurong.—Java, from Sumatra, Wakker, 1896.

Husbands.—Barbados, a red sport, Rept. 1905–7: 34, 1908.

HVA.—(Initials with numbers): Java, Knifer, Med. 5, 1919.

Hybrid Fooliogoo.—Queensland, from Mauritius, 1901, Easterby.

Hybrid Galaga.—Queensland, from Mauritius, 1901, Easterby.

Idjo.—Java, from Java, Wakker, 1896.

Idjo Hong Kong.—Java, Soltwedel, Fig. 29. The plate represents a slender, long-jointed, green cane with swollen nodes and very broad but indistinct growth ring. It probably belongs in the *Saccharum sinense* group.

Idjo Kaliwoengoe.—Oost-Java, Med. 47.

Idjoe.—Java, from Cochin China, Wakker, 1896.

Iduari.—Queensland, from New Guinea, 1895. Cowley's Collection, Easterby, Bull. 2, 1926.

Ignorada.—Argentina, from Peru, Cross, Facts About Sug. 5/23–25, p. 495, susceptible to frost damage and to mosaic, of no value here.

Imperial.—Jamaica, = Violet Cane, MacFadyen (= Black Cheribon); Queensland, from Mauritius, 1877, resembles Guingham, Easterby, (= Striped Tanna?); Brazil, a green and yellow striped cane, Deerr; Argentina, from Brazil, Zerban. Susceptible to gum disease, E. F. Smith (Brazil and Argentina = Green Ribbon = Calancana); Philippines, Mendiola, Identification Key, Plant News 8(1), Jan., 1922, = Striped Cheribon.

Imperial del Brazil.—Porto Rico, = Carandali, = Calancana, Stahl, Lopez Tuero, (= Green Ribbon or Striped Otaheite).

Inalmon.—Philippines, = Black Manila, Hines, Agr. Rev. 8: 153, 1915, = Negros Purple, H. Atherton Lee (in lit. 6/17–21).

India.—Argentina, from Brazil, Zerban, 1910.

India de Jujuy.—Argentina. A plantation name for a mixture of Criolla Blanca (=Crystalina) and Verde de Jujuy (= Otaheite), Fawcett, Rev. 9: 135, 1919.

Indian Purple.—Formosa, Ishida, Sug. Sta. Bull. 1: 44, 1920.

Indian Striped.—Formosa, Ishida, Sug. Sta. Bull. 1: 44, 1920.

Induari.—Queensland, from New Guinea, Maxwell, Easterby.

Induria.—N. S. Wales, Int. Sug. Jour., 1: 506, 1899.

Innis.—(With numbers): Queensland, from Mauritius, 1901, Easterby.

Irimotu.—Society Islands, Cruzent, 1860, = *Saccharum fragile;* Tahiti, Bennett, The Sugar Cane, 6:593, 1874, = Yellow Tahitan (not Otaheite).

Iscambine.—Mauritius, from New Caledonia, 1870, Dept. Agr. Bull. 2:5 and 11, 1916, The Iscambine Canes, Deerr. The striped Iscambine = Tsimbec, from New Caledonia. Iscambine Rouge is a sport from the Striped (see Escambine).

Iscambine Rayée.—Mauritius, Boname, Repts., 1895, 1898–9.

Iscambine Rouge.—Mauritius, Boname, Repts., 1895, 1898–9.

Ischiemie.—Queensland, from New Caledonia (Caldwell) Davidson, 1880; from So. Sea Islands, 1874, Easterby (seems to be a misprint from Iscambine).

Ischikanemba.—Mauritius, from New Caledonia (Lavignac) Horne, 1869.

Isumba.—Mauritius, from New Caledonia (Lavignac) Horne, 1869.

Itam.—Mauritius, from Java, Horne, 1869 (see Hitam, etc.) = Black Cheribon; Java, = Monjet de Cheribon, Krajenbrink, The Sugar Cane, 2:190, 1870.

Itam Klampei.—Java, from Borneo, Geerligs, West-Java, Med. 27.

Item.—Java, Gonzalves, = Black Cheribon; Java, from Sumatra, Wakker, 1896.

Item Billiton.—Java, Wilbrink and Ledebour, Med. 6:86, 1811.

J.—(Initial with numbers): Seedling canes produced in Jamaica.

Jaganathia.—India, Barber, Studies, 3.

JAM.—(Initials with numbers): Barbados, Rept. 1917–19:60.

Jamaica.—Barbados, = Mont Blanc (= Crystalina), Rept. 1902; Demerara, = Guiana (= Otaheite), Horne, 1869.

Jamaica Amarilla.—Peru, = Otaheite, Zerban, Rev. Tuc. 1:29, 1910.

Jamaica Elephant.—Demerara, Rept. 1894–5.

Jamaica Transparent.—See Elephant, Bull. 4:227, 1897.

Japanese.—Louisiana, Agee (= Zwinga).

Japara.—Java, from Java, Wakker, 1896; Deerr, 49, probably =Diard Rose, = Crystalina.

Japara Njamplong.—Java, Kobus, Med. 6, 1893.

Jappara Djawa.—Sagot, 330, 1893.

Japparah Bali.—Sagot, 329, 1893.

Japparah Bina.—Sagot, 339, 1893.

Japparah Glagah.—Sagot, 329, 1893; Java, Kobus, Med. 6, 1893.

Japparah Malan.—Sagot, 330, 1893.

Jate.—New Caledonia, Vieillard, 1863, Sagot, 347.

Java.—Louisiana, from Hawaii, Agee; Demerara = Black Cheribon, Harrison and Jenman; Jamaica, Bot. Dept. Bull.?; India, Barber, Studies,?. (In the older literature it usually refers to the Cheribon canes. In recent literature, especially when used with numbers, it is more likely to refer to the POJ series).

Java Hebbal.—India, Int. Sug. Jour., May, 1923, p. 243. Has best sugar content among the thick canes, is hardy and heavy yielder.

Jenman.—Demerara, Harrison and Jenman.

Jolo Purple.—Philippines, H. Atherton Lee (in lit. 5/27–21), a color variant of Jolo White.

Jolo Striped.—Philippines, H. Atherton Lee (in lit. 5/27–21). White with green stripes, a color variant of Jolo White.

Jolo White.—Philippines, H. Atherton Lee (in lit. 5/27–21). A new cane discovered in the island of Jolo, Sula Archipelago. There are striped and purple variants. All are characterized by an enlarged rib or ring just above each node.

Jowari White.—Bombay, India, Knight (see Niliva).

Julian.—Argentina, from Brazil, Zerban (see Morado del Pais = Louisiana Purple).

Junction.—Brazil, = Ensertada.

JV.—(Initials with numbers): Java, Herreveld, Med. 3: 1028, 1919.

Kabbu.—Madras, India, Barber, Studies, 3.

Kabirya.—Bombay, India, Knight, = Ramrasdali.

Kabopolenounen.—New Caledonia, Vieillard, 1863, Sagot, 345.

Kadi.—Bombay, India, Watt's Dict. 6(2): 73.

Kadjule.—Bengal, India, Watt's Dict. 6(2): 57. (See also colored illustration published by East India Co., 1792.)

Kaghze.—India, Barber, Studies, 2, 3 (see Kughaze, Watt's Dict. 6(2): 62).

Kagli.—India, Watt's Dict. 6(2): 57.

Kahi.—India, Barber, Studies, 1. The native name for the wild cane, *Saccharum spontaneum*, "Red or yellow, leaves narrow or broadish, sheaths spiney or smooth, circlet of hairs abundant or nearly absent, buds densely hairy to nearly glabrous, small and placed low down on joint to elongate and high up, etc. Juice 3–5 per cent sucrose. It crosses readily with cultivated kinds. Seedlings of cultivated kinds often throw back to this native type."

Kahu.—India, Watt's Dict. 6(2): 67, Barber, Studies, I, The Sugar Cane 15: 644, 1993. Int. Sug. Jour., 23: 661, 1921, "Of Pansahi class, only slightly frost resistant."

Kaingyran.—Burma, Watt's Dict. 6(2): 78.

Kainio.—Louisiana, from Hawaii, Stubbs, Agee.

Kaiva.—India, Watt's Dict. 6(2): 60.

Kajali.—India, Watt's Dict. 6(2): 57, Bengal, 60.

Kajla.—Java, from British India, Kobus, Med. 48, 1893.

Kajoole.—India, Roxburgh, under *Saccharum officinarum.*

Kaka.—Burma, from India, Facts About Sug. 10/7–22, p. 301.

Kakeo.—Mauritius, from Sandwich Islands, Horne, 1869.

Kakoe.—Jamaica, from Mauritius, 1882, D. Morris (see above).

Kakonakona.—Mauritus, from Sandwich Islands, Horne, 1869.

Kala.—Cent. India, Watt's Dict. 6(2): 69; Bombay (Ozanne) p. 74. Used as a class name including several varieties. The name means black, Deerr (in lit. 5/25–1921).

Kalamboewei.—Java, from Sumatra, Wakker, 1896.

Kalariya.—India, Watt's Dict. 6(2): 72.

Kali Gond Girri.—India, Watt's Dict. 6(2): 70.

Kali Woengoe.—Java, Kobus, Med. 6, 1893.

Kalkhra.—Bombay, India, Barber, Studies, 3.

Kalkya.—Bombay, India, Knight.

Kalo-Zhenna.—Nepale, India, Watt's Dict. 6(2): 66.

Kaludai Boothan.—India, Barber, Studies, 2.

Kama.—Java, from Sumatra, Wakker, 1896.

Kamba-Kamba-Vati.—Demerara, Harrison and Jenman.

Kamrange.—Assam, Stack, = Bhabeli.

Kam Shaanche.—Greenhouses, Washington, 6/21–26.

Kanangari.—Mauritius, from New Caledonia (Lavignac), Horne, 1869. (See also Kavarangri and Kavenger. Is this the original form of Kavangire and Cavengirie ?)

Kanara.—India, Barber, Studies, 1; North India, Barnes, The Sugar Cane 15: 594 and 644, 1883.

Kansar.—India, Barber, Studies, 1, 3; North India, Barnes.

Kansia.—India, Watt's Dict. 6(2): 69, 70.

Kanton White.—Formosa, Ishida, Sug. Sta. Bull. 1: 43, 1920.

Kapoer.—Java, from Borneo, Sumatra, and Malacca, Wakker, 1896.

Kara Kabbu.—Bombay, India, Watt's Dict. 6(2): 73.

Kara-Karawa.—Demerara, Harrison and Jenman.

Kare.—India, Watt's Dict. 6(2): 73.

Kare Rasdali.—Bombay, Knight (see Tambada).

Karikarimbon.—Haiti, mentioned by Tussac, 1808.

Karum.—India, Barber, Studies, 2.

Kassoer.—Java, Kobus, Med. 6, 1893; Wakker, 1896; Wilbrink and Ledeboer, Med. 6: 86, 1911; E. F. Smith, Bact. 3: 76, immune to sereh; Van Derventer, Handb. 5: 129, 1915, a wild cane; Jeswiet with full desc., Med. 13: 405, 1911.

Katara.—North India, Barnes.

Katarya.—India, Watt's Dict. 6(2): 70.

Katha.—India, Barber, Studies, 1, 2; North India, Barnes; Punjab, India, the kind principally grown in the district, is nearer to *Saccharum spontaneum* than any cane in India, Rept. Ind. Sug. Committee, Int. Sug. Jour., Sept., 1921, p. 558.

Kathia.—India, Watt's Dict. 6(2): 67.

Katu.—Punjab, India, Watt's Dict. 6(2): 66.

Kava.—Java, from Borneo, Wakker, 1896.

Kavangeri.—Bahia, Brazil, The Sugar Cane, 22: 483, 1890.

Kavangire.—Argentina, from Brazil, Zerban, 1910; Fawcett, = Uba, = Sin

Nombre 54, = Bambu de Tabandi, Rev. Tucuman 9:144, 1919, with desc. and fig. [The identification as = Uba is a mistake. As grown side by side in Cuba the Kavangire from Argentina via Porto Rico and Uba direct from Natal, while closely similar, are clearly distinct.]

Kavangire de Santa Barbara.—Argentina, from Brazil, Zerban, 1910.

Kavangy.—Brazil, T. Weller, The Sugar Cane, 25:187, 1893 (= Kavangire).

Kavarangri.—New Caledonia, Breslau, 1884, Sagot, 335. A large deep-red cane (= Cavengerie ?).

Kavenger.—Mauritius, Boname, Rept. 1898–9, = New Caledonia Queen (= Cavengerie ?) (See also Kanangari.)

Kdam.—Cambodge, Sagot, 326.

Keening.—Demerara, Harrison and Jenman, = Naga.

Kehkers.—Mauritius, from Java, Horne, 1869.

Kekarea.—Queensland, from New Guiena, Maxwell 1903–4.

Kelie.—Madras, India, C. A. Benson, Int. Sug. Jour., 2:469, 1900.

Kemboeay.—Java, from Sumatra, Wakker, 1896.

Keni Keni.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison and Jenman, = Nora Tava; Hawaii, Deerr and Eckert = Oudinet (brought from Otaheite with Lahaina by Capt. Edwards), Rock, Plant Names, Bull. 2, 1923; Java, from Malacca, Wakker, 1896; Mauritius, Boname, Rept. 1896 and 1898–9, = Otaheite, Deerr.

Keong.—Java, from Java and Borneo, Wakker, 1896; Kruger, with Colored Pl. No. 2, = Teboe Bessi, Soltwedel Pl. 15; Soltwedel Fig. 15, Teboe Keong, represents a medium-stout, dark purple cane with surface cracks, nodes abruptly constricted below the leaf scar, which shows a peculiar V-shaped folding, groove conspicuous, buds all strongly developed, which is said in the text to be characteristic of the variety.

Kerah.—Java, from Sumatra, Wakker, 1896; E. F. Smith, Bact. 3:77, immune to sereh.

Ketar.—India, Papers, etc., Sugar, 3d. App. 35, 1822; Watt's Dict. 6(2):62.

Kew Seedlings.—(With numbers): Queensland, from Mauritius, Easterby, 1901, Bull. 2, 1926.

Kewahi.—India, Clark and Hadi.

Kewali.—India, Taylor, Woodhouse; of the Nagori group, semi-aquatic Int. Sug. Jour., Feb., 1925, p. 81, Oct., 1925, p. 532.

Kewensis.—Queensland, from Kew Gardens, prior to 1895, Easterby, Bull. 2, 1926; E. F. Smith, Bact. 3, susceptible to gum disease.

Khadkya.—Bombay, India, Watt's Dict. 6(2):74.

Khadya.—Bombay, India, Barber, Studies, 3; Knight, Bull. 61, 1914. (= Wansia).

Khagari.—Assam, Stack, Watt's Dict. 6(2):62.

Khagri.—Bengal, Watt's Dict. 6(2):60; Taylor, Woodhouse.

Khajla.—India, Watt's Dict. 6(2):69; Woodhouse, possibly a degenerate Red Mauritius.

Khajuria.—Bombay, India, Knight, = Mewa or White Surati.

Khari.—India, Barber, Studies, 2, 3; Barnes, Taylor, Woodhouse, Sayer.

Khelia.—India, Barber, Studies, 2; Taylor, Woodhouse.

Khera.—Georgia, from United Provinces, India, P. A. Yoder, Sugar Cane for Syrup, p. 260; La. Plant. 7/3–26, p. 6. Resembles Uba; one of the *Saccharum sinense* canes, susceptible to mosaic but tolerant, Brandes and Klaphaak.

Kiabone.—New Caledonia, Vieillard, 1863; Sagot, 345.

Kiewahee.—India, Papers—Sugar, 1822.

Kikaigashima.—Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920; Brandes and Klaphaak, Breeding Resistant Sugar Plants. One of the *Saccharum sinense* canes, susceptible to mosaic but tolerant; Georgia, from Japan, P. A. Yoder, La. Plant., 7/3–26, p. 6.

Kikarea.—Queensland, from New Guinea, 1895, Easterby.

Kikil.—Java, from Sumatra, Wakker, 1896.

Kikir.—Java, from Sumatra, Wakker, 1896.

Kikir Andjing.—Java, from Sumatra, Wakker, 1896.

Ki Kon Ona.—New Caledonia, Breslan, 1884, Sagot, 333.

Kilang.—Java, from Borneo, Sumatra, Wakker, 1896.

Kilkie.—Java, from Sumatra, Wakker, 1896.

Killie.—Java, from Malacca, Wakker, 1896.

Kinar.—North India, Barnes; Cuba, from U. S. Dept. Agr., 1925.

Kinemaite.—New Caledonia, Vieillard, 1863, Sagot, 345.

Kiong.—Mauritius, from Java, Horne, 1869.

Kirkirandjing.—Java, from Bovenlanden, Wakker, 1896.

Kirnya.—India, Watt's Dict. 6(2):57.

Kissaman.—Argentina, from Brazil, Zerban, 1910, = Morado del Brazil, = Cavengerie ?

Kiwahi.—Benares, India, Watt's Dict. 6(2):57.

Klawoe.—Java, Harreveld, = Wit Manila.

Klidang.—Java, Geerligs, Med. West-Java 27.

Knox.—Mauritius, Boname, 1896, 1898–9.

Ko.—Hawaii, Rock, Plant Names, Bull. 2, 1913. A native name for sugar cane in general.

Koeal.—Java, from Sumatra, Wakker, 1896.

Koembie.—Mauritius, from New Caledonia (Lavignac) Horne, 1869.

Koeng.—Oost-Java, Med. 7:4.

Koeng Bayowman.—Java, Kobus, Med. 5, 1893.

Koeng Sambas.—Java, Kobus, Med. 6, 1895.

Koening.—Mauritius, from Java, Horne, 1869, = Rappoe Koening; Java, from Fiji, New Guinea, Banka, Borneo, Wakker, 1896; Soltwedel, Teboe Koening, Fig. 3. The plate represents a yellow, long-jointed cane of medium diameter, nodes somewhat constricted, rudimentary roots in 3 rows, furrow conspicuous for full length internode, buds

ovate. Looks much like Otaheite; Queensland, from Java, 1874, Easterby.

Koerik.—Java, from Sumatra, Wakker, 1896.

Koerik Solase.—Java, from Sumatra, Wakker, 1896.

Koering.—Java, from Sumatra, Wakker, 1896.

Koesoemo.—Java, Harreveld, Med. 15:1597, 1917; Jeswiet, Med. 17:34, 1917.

Koewal.—Java, from Sumatra, Wakker, 1896.

Koimbé.—New Caledonia, Breslan, 1884, Sagot, 335.

Kokea.—Hawaii, Eckert, Bull. 17:9, 1906; Rock, 1913: A greenish-white native cane, Deerr; Louisiana, from Hawaii, Stubbs, Agee; Queensland, from Hawaii, = Lahina, Easterby.

Kokeia.—Jamaica, from Mauritius, 1882, D. Morris; Java, from Malacca, Wakker, 1896.

Kondang.—Java, from Sumatra, Wakker, 1896.

Kondimona.—New Caledonia, Vieillard, 1863, Sagot, 348.

Ko Pake.—Hawaii, = Cuban.

Ko-Poa-Pa.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison and Jenman.

Ko-Puaole.—Hawaii, Eckert, Bull. 17:9, 1906.

Koring.—Java, from Sumatra, Wakker, 1896.

Korpi.—Queensland, from New Guinea, 1914, Easterby, Bull. 2, 1926, = 14 NG, 124 C.S.R. Co.

Kossoer.—Oost-Java, Med. 47, 53 (see Kassoer).

Kotarea.—India, Watt's Dict. 6(2):70.

Koubala.—New Caledonia, Vieillard, 1863, Sagot, 345.

Krebet.—(With numbers): Java, Harreveld, Med. 4:1654, 1919.

KS.—(Initials with numbers): Java, Ledeboer, Med. 4:452, 1917.

Kuchhra.—India, Watt's Dict. 6(2):69.

Kughaze.—India, Watt's Dict. 6(2):62 (see Kaghze).

Kuku Sari.—Queensland, from Fiji, 1878, Easterby.

Kullerah.—India, Watt's Dict. 6(2):57. Illustrated by the East India Co. in 1792, a light-colored cane growing in swampy land.

Kulloa.—Stubbs, Deerr, = Bamboo.

Kullooa.—India, Roxburgh, under *Saccharum officinarum.*

Kullore.—India, Deerr, the first cane to be called Bamboo. (Do these four names all refer to the same variety?)

Kumied Kala.—Punjab, India, Watt's Dict. 6(2):66.

Kumied Lahore.—Punjab, India, Watt's Dict. 6(2):66.

Kundiari.—India, Watt's Dict. 6(2):67.

Kuning.—Java, Kruger 145 (see Soltwedel III), = Tebu Teelor.

Kusha-tu.—Nepal, India, Watt's Dict. 6(2):66, = Kalo-Zhenna.

Kuswar.—India, Clark and Hadi.

Kutara.—Java, from British India, Kobus, Med. 49, 1893; India, Watt's Dict. 6(2):62.

Kutharee.—India, Papers, Sugar, App. 1: 193, 1822.
Kutiar.—India, Watt's Dict. 6(2): 67.
Kyannet.—Burma, Watt's Dict. *(2): 78.
Kyoukgoungyan.—Burma, Watt's Dict. 6(2): 78.

L.—(Initial with numbers): Seedlings produced in Louisiana.
Lahaina.—Hawaii (name from Lahaina plantation), from the Marquesas (Pardon Edwards), = Bourbon, Colony Cane, Otaheite, Loucier, Portier, Bamboo II, China II, Cuban, Eckert, Bull. 10: 4, 1905; Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison; Java, from Malacca, Wakker, 1896; Mauritius, Boname, 1895; Argentina, Fawcett, Rev. 9: 138, 1919 with desc. and fig.
Lahi.—Hawaii, Rock, = Ko, a native name for sugar cane.
Lahira.—Java, Kobus, Med. 6, 1893.
Lahria.—Java, from Malacca, Wakker, 1896.
Lakonia.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison and Jenman, = Sacuri; Java, from Malacca, Wakker, 1896; Louisina, from Jamaica, Stubbs, Agee. (The name seems to have originated in Jamaica.)
Lal.—North India, Barnes.
Lalanjore.—Pernambuco, Brazil, E. F. Smith; resistant to gum disease.
Lalgainra.—Bengal, India (Chapman) Watt's Dict. 6(2): 60.
Lalri.—India, Watt's Dict. 6(2): 66; North India, Barnes, Barber, Studies, 1, 3.
Lamark.—Java, from Sumatra, Wakker, 1896.
Landjoeng.—Java, from Leorew, Wakker, 1896.
Lania.—Queensland, unknown origin, 1878, Easterby.
La Pice.—Louisiana, from Java, = Crystalina, Stubbs.
Laren.—Java, (from ?) Wakker, 1896.
Large Green.—Demerara, Harrison and Jenman.
Lata.—India, Taylor, Woodhouse.
Laujon.—Java, from Malacca, Wakker, 1896 (Louzon ?).
Laukona.—Hawaii, Rock, = Ribbon Cane (see Lakona).
Ledi.—India, Watt's Dict. 6(2): 67.
Ledoo.—India, Watt's Dict. 6(2): 70 (see also Ledu, p. 72, and Ledi, p. 67).
Ledu.—India, Watt's Dict. 6(2): 72.
Leeut (Tibboo Leeut).—Straits Settlements, Wray, = Bourbon; Queensland (Tabor Leeut), Easterby, Bull. 2, 1926.
Lench.—Java, Kobus, Med. 6, 1893.
Le Sage.—Mauritius, Boname, 1895.
Le Sassier.—Louisiana, from Java, = Crystalina, Stubbs, Agee.
Lewari.—India, Taylor, Woodhouse.
Liat.—Java, from Sumatra and Billiton, Wakker, 1896.
Lielien.—Mauritius, from Java, Horne, 1869.

Lielium.—Australia, Brisbane Bot. Gar., from Java, The Sugar Cane 2:104, 1870.

Liembat.—Java, from Sumatra, Wakker, 1896.

Light Cheribon.—From Java, Deerr, = Blue, Burk, Crystalina, Green, Hope, La Pice, Le Sassier, Light Java, Mamuri, Mexican Bamboo, Mird, Mont Blanc, Naga B, Panachee, Rappoh, Rose Bamboo, White Transparent, Yellow Singapore. [These are now said by Jeswiet to be mostly Light Preanger.]

Light Java.—Louisiana, from Jamaica, Stubbs, Agee, = Crystalina, etc.

Light Purple.—Australia, Melmouth Hall, The Sugar Cane, 6:588, 1874, (= Crystalina), Int. Sug. Jour., 1:506, 1899. General planting permitted by Colonial Sugar Co.

Liguanea.—Jamaica, Bot. Bull. 2; Louisiana, from Jamaica, Stubbs, Agee. (Name seems to have originated in Jamaica.)

Lilien.—Queensland, from Java, Davidson, 1880; from Java, 1876 Easterby (see Lielien).

Lingga.—Java, from Sumatra, Wakker, 1896.

Lingga Koering.—Java, from Sumatra, Wakker, 1896.

Linggo of Gondang.—Java, from Sumatra, Wakker, 1896.

Listada.—Porto Rico, 1878, Stahl (= Striped Preanger); Argentina, from Brazil, Zerban, 1910.

Listas Verdes y Moradas.—Porto Rico, 1878, Stahl.

Listrado de Amarilla.—Brazil, = Roixa, Moreira, 1876.

Listrado de Roixo.—Brazil, = Solangor, Moreira, 1876.

Little Ribbon.—Australia, from New Caledonia, Angus Mackay, 1870.

Little Yellow.—Australia from New Caledonia, similar to Tabor Portii from Java, Angus Mackay, 1870.

Llamao White.—Philippines, Reeikin, Sug. News 2:94, 1921.

Loegoet.—Java, from Java, Wakker, 1896.

Loemar.—Java, from Borneo, Wakker, 1896.

Loemar Soerat.—Java, Kobus, Med. 6, 1893.

Loethers.—Java, from Mauritius, Wakker, 1896, Soltwedel, Fig. 8. The plate represents a long-jointed, medium-diameter, hazel-brown cane. In the text it is stated that when shaded it remains yelllow-green. Nodes prominent, rudimentary roots small, in 2–3 rows, growth ring broad and conspicuous, buds ovate-triangular. The name is a misreading of Soethers, and has nothing to do with Louzier, with which it is sometimes confused. Deerr, 612; resistant to sereh. E. F. Smith; Jeswiet, Med. deel? 6(13):383, 1916 with full desc.; Geerlings, Sug. Ind., 125, 1912.

Loleba.—Java, from Amboina, Wakker, 1896.

Loma Loma.—Java, from Malacca, Wakker, 1896.

Longil.—Queensland, from So. Sea Islands, 1878, Easterby.

Louisiana Purple.— = Black Preanger.

Louisiana Ribbon.— = Striped Preanger.

Louisiana Striped.— = Striped Preanger.

Lousier.—(Also spelled Loucier and Louzier): Mauritius, originating as a bud sport from Striped Mignone, Agr. Dept. Bull. 2:11, 1916, it later sported again, giving rise to green-striped and solid red forms; indistinguishable from Otaheite, Deerr; Java, Kruger, = Loethers (a mistake); Brazil, all citations = Cavengirie (evidently a mixing of labels); Argentina, from Brazil = Cavengirie; Cuba, probably from Louisiana. The Louisiana stock came from Reynoso in Cuba, who claims it came from Mauritius. The cane now at the Cuban Exp. Sta. under this name is not Otaheite but more nearly resembles what is there known as Bamboo Blanca.

Lousier de Mauricio.—Argentina, from Brazil, Zerban, 1910; Fawcett, Rev. 9:137, 1919. Agrees with Cavengirie except in color. It is yellow with faint purple striping in older joints.

Lousier Rayée.—Mauritius, Boname, 1895, 1898–9, = Green Ribbon, Deerr.

Lousier Rayé Rouge.—Mauritius, Boname, 1898–9, = Horne, Deerr.

Lousier Rayé Verte.—Mauritius, Boname, 1898–9, = Green Ribbon, Deerr.

Lousier Rouge.—Mauritius, Boname, 1898–9; Queensland, from Mauritius, Easterby, Maxwell.

Lugut.—Java, Kruger, 141.

Luzon White.—Philippines, Mendiola, Phil. Farmer, Aug., 1920, p. 63; H. Atherton Lee (in lit. 6/17–21), = White Luzon, White Manila, Wit Manila, Philippine Blanche. The light-colored variant of the common native Philippine cane. Pampanga Red is the red variant and Negros Purple a black variant. The Jolo canes form an entirely distinct series.

M.—(As initial with numbers): Seedlings grown in Mauritius (see also Barbados Rept. 1915–17; 72). A cane from Formosa has been distributed by Brandes, U. S. Dept. Agr., as 36 M. It is said to be a bud sport from POJ 36 (see Mingka).

M.—(As initial with numbers, Java): Seedlings grown by Moquette.

Mabuan.—Queensland, from New Guinea, Maxwell, Easterby.

Macao de Sao Simao.—Argentina, from Brazil, Zerban, 1910.

Machal.—India, Watt's Dict. 6(2):71.

Macravati.—New Caledonia, Breslau, 1884, Sagot, 339.

Madras Cane.—Burma, Watt's Dict. 6(2):78.

Madras Seedlings.—India, Barber, Studies, 2.

Magara.—India, Watt's Dict. 6(2):62, = Malaha.

Magh.—Assam, Agr. Inst. Pusa, Bull. 83:41, 1919 (see Maugh).

Mahnoe.—Java, from Sumatra, Wakker, 1896.

Mahoaovu.—Queensland, from New Guinea, 1895, Easterby, = Mavoe.

Mahona.—Queensland, from New Guinea, as No. 22, 1896, Easterby.

Mahvoavi.—(With numbers): Queensland, from Mauritius, 1901, Easterby.

Mailagir.—India, Watt's Dict. 6(2):67.

Maillard.— = Striped Tanna, Deerr.

Maion.—New Guinea, Vieillard, 1863, Sagot, 345.

Majore Perle.—Queensland, from Mauritius, 1878, Easterby.

Majore Rouge.—Queensland, from Mauritius, 1878, Easterby.

Majori.—Queensland, from Mauritius, 1878, Easterby.

Makassar.—Java, Kobus, Med. 6, 1893, Van Derventer, Handb. 5:151, 1915. Imported in 1886.

Makassar Idjoe.—Java, Kobus, Med. 6, 1893.

Makassar Soerat.—Java, Kobus, Med. 6, 1893.

Malabar.—Queensland, from Mauritius, 1874, Easterby; E. F. Smith, resistant to gum disease, = White Tanna, = Yellow Caledonia, Deerr.

Malabarde.—Porto Rico, Lopez Tuero, 10, = Morada; Stahl, Revist. Agr. 1887, p. 174, = Morada or Listas Moradas (= Rayada).

Malagache.—Queensland, from Mauritius (with numbers) Easterby, Bull. 2, 1926; Mauritius Malagache, Philippines, F. J. Gamboa (in lit. 8/26–25), a heavy, long-jointed, dark purple cane, with heavy stools, ratoons well (see Malgache).

Malaha.—India, Watt's Dict. 6(2):62, = Magara or Megala.

Malaman.—Mauritius, from Java, Horne, 1869; Queensland, from Java, prior to 1874, Easterby, Bull. 2, 1926 (see Malmaman).

Malawan.—Java, from Java, Wakker, 1896.

Malay.—Jamaica, Bot. Bull. 2; Louisiana, from Jamaica, Stubbs, Agee, = Green Rose Ribbon Stubbs, Deerr.

Maldo.—Java, from Sumatra, Wakker, 1896.

Malem.—Java, from Bali, Wakker, 1896.

Malgache.—Mauritius, Dept. Agr. Bull. 2:5, 1916; Queensland, with numbers, from Mauritius, 1901, Easterby (see Malagache).

Malmaman.—Queensland, from Java, 1874, Easterby (see Malaman).

Malmont.—Philippines, Mendiola and Unite, Phil. Agr. 13(2):119, 1924.

Mam Blam.—Jamaica, Jour. Agr. Soc. 20:12, 1896, = Black Ribbon.

Mamendon.—Queensland, from So. Sea Islands, 1874, Easterby.

Mamulele.—Hawaii, the purple-leaved cane, Deerr, 61 (= Djamprik).

Mamuri.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, = White Transparent, Harrison and Jenman; Java, from Malacca, Wakker, 1896, = Crystalina, Deerr.

Manau.—Java, from Sumatra, Wakker, 1896.

Manch of Basali.—North India, Barnes.

Maneria.—India, Taylor, Woodhouse, Barber, Studies, 2.

Mangis.—Java, from Java, Wakker, 1896; Soltwedel, Fig. 9. The plate shows a stout, reddish-brown, short-jointed cane, internodes straight, cylindrical, nodes prominent, buds large, irregularly ovate.

Mangis Idjo.—Java, from Java, Wakker, 1896; Soltwedel, Fig. 6. A medium-stout green cane with no flush, internodes straight, cylindrical, furrow slight, nodes not constricted, rudimentary roots in 3–4 rows, glaucous band strongly developed, buds large, broadly ovate.

Mangis Seloredjo.—Java, Kobus, Med. 6, 1893.
Mangis Soerat.—Java, from Java, Wakker, 1896.
Mangli.—Java, from Java, Wakker, 1896.
Mangli Betoel.—Java, from Java, Wakker, 1896.
Mangli Brangkal.—Java, Kobus, Med. 6, 1893.
Mangli Idjo Kendal.—Java, Kobus, Med. 6, 1893.
Mangli Soerat.—Java, Arch. 1, ap. 1892.
Mango.—India, Papers—Sugar, 3d. ap. 35, 1822; Watt's Dict. 6(2):57, Barnes, Taylor, Woodhouse. A dwarf cane ripening late at Bihar, Sayer, Ind. Sug. 13.
Mani.—Demerara, = Norman, Harrison and Jenman.
Manigo.—India, Watt's Dict. 6(2):60.
Manila.—Java, Kobus, Med. 6, 1893; E. F. Smith, Bact. 3:77, resistant to serch.
Manila Black.—Java, = Cebu Purple, Philippines, H. Atherton Lee.
Manila Red.—Java, = Pampanga Red, Philippines, H. Atherton Lee.
Manila White.—Java, = Luzon White, Philippines, H. Atherton Lee.
Manjao.—A selection made at Manjri, Bombay, is of great value for water-logged areas under canals, Int. Sug. Jour., May, 1923, p. 245 (recognized by R. G. Padhye, on a visit to Porto Rico, as = Crystalina).
Manteica de Sta. Barbara.—Argentina, from Brazil, Zerban, 1910.
Manteiga.—Brazil, Pernambuco Sta. Bull. 3, Gorkum 26, 1915, = Enver-nizda, = Calvacante, = Flor de Cuba, = San Pello, Deerr.
Manulete.—Hawaii, Eckert, Bull. 17:9, 1906; Louisiana, from Hawaii, = Akilolo, Stubbs; Queensland, from Hawaii, 1880, Easterby.
Mapnoe.—Java, from Sumatra, Wakker, 1896.
Mapou.—Mauritius, Boname, 1895, 1898–9; Queensland, = Black Java, Easterby; Réunion, Colson. The name comes from a district in Mauritius, Deerr (in lit. 5/25–21).
Mapou Perle.—Brazil, Sao Paulo, Sawyer, 1908; Bahia, Brazil, The Sugar Cane 22:483, 1890; Argentina, from Brazil, Zerban, 1910.
Mapou Rayée.—Mauritius and Réunion, from New Caledonia, Sagot, 328; Guadeloupe, Boname, 1888.
Mapou Rouge.—Brazil, Sao Paulo, Sawyer, 1908; Bahia, Sugar Cane 22: 483, 1890; Argentina, from Brazil, Zerban, 1910; Réunion (Delteil), Sagot, 330.
Marabal.—(Often spelled Marabel): Jamaica, from Mauritius, 1882, D. Morris; Louisiana, from Jamaica, Stubbs, Agee; Queensland, from Louisiana, 1895, Easterby.
Maracabo.—India, Papers, Sugar, Ap. 3:12, 1822.
Mara-Kabo.—India, Watt's Dict. 6(2):76.
Marnoe.—Java, from Sumatra, Wakker, 1896.
Maroe.—Java, from Borneo, Wakker, 1896.
Martinique.—Jamaica, Bot. Bull. 2, a white slender cane; The Sugar Cane

17:153, 1885, article on the exhibit of 58 varieties of sugar cane from Jamaica at the New Orleans Exposition, a dark purple cane adapted to dry regions; Island of Vieques, Porto Rico, a local name for a red cane, apparently = Black Cheribon, also said to be a yellow Martinique, in Vieques.

Mas.—Java, Geerlings, West-Java, Med. 27.

Masiek.—Java, from Sumatra, Wakker, 1896.

Massambara.—Brazil, Weller, The Sugar Cane, 25:187, 1893.

Massiek.—Java, Arch. I., Ap., 1892.

Mataca.—Argentina, from Brazil, Zerban, 1910.

Matki Mango.—North India, Barnes.

Matna.—India, Watt's Dict. 6(2):62; North India, Barnes.

Maugh.—India, M. Ahsanulla, largely grown in Assam, full desc. given, Facts About Sugar 7/10–26, p. 667.

Mauritius.—Bengal, India, = Bourbon, Wray; India, from Mauritius, 1827, = Otaheite, Watt's Dict. 6(2):41; Java, from British India, Kobus, Med. 48, 1893, brown red, sheaths hairy; Australia, Tryon, = Striped Guingham; susceptible to gum disease, E. F. Smith, Bact. 3:69; Natal, Storey, Rept. Imp. Bot. Congress 1926, p. 137. Susceptible to both streak disease and mosaic. (Evidently a mixture under this name.)

Mauritius Couve.—Queensland, Easterby.

Mauritius Diard.—Queensland, from Mauritius, 1878, Easterby.

Mauritius Guingham.—Queensland, from Mauritius, 1878, Easterby; Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920.

Mauritius Malagache.—Philippines, Mendiola, Phil. Farmer, Aug., 1920, p. 63; Sugar News 3(1), Jan., 1922.

Mauritius Malagache.—Philippines, from Australia, Hines, Agr. Rev. 8:157, 1915 (Mauritius).

Mauritius Meerah.—Queensland, from Mauritius, 1878, Easterby.

Mauritius Ribbon.—N. S. Wales, Int. Sug. Jour., 1:506, 1899; planting permitted by Colonial Sug. Co., = Striped Cheribon.

Mavâl Pundia.—"As grown at Manjri Farm, Poona, India, this is the same as Creole as seen in Porto Rico." Verbal statement by R. G. Padhye on his visit to Porto Rico, 10/17–22.

Mave.—Queensland, from New Guinea, = Nave, Maxwell, Easterby.

Mavoe.—Queensland, from New Guinea, = Mahoaovu, Maxwell, Easterby.

Mebouangué.—New Caledonia, Vieillard, 1863, Sagot, 346.

Meera (or Meerah or Merah).—A Malay word meaning red. In the literature the name usually applies to Black Cheribon but other red or purple canes may be included. Java, Soltwedel, Fig. 12, Tebo Merah, represents a purplish-red cane of medium diameter, buds broadly ovate with a broad uniform margin. If intended for Black Cheribon the buds are badly drawn.

Meligeli.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, = Bamboo I and II; Java, from Malacca, Wakker, 1896. (See Neligeli.)

Menado.—Java, Kobus, Med. 6, 1893.

Mendjalong.—Java, from Billiton, Wakker, 1896.

Mendku.—India, Watt's Dict. 6(2): 67.

Menoe.—Java, from Sumatra, Wakker, 1896.

Merah.—(See Meera.)

Merah Borneo.—Argentina (see Borneo).

Merati.—India, Watt's Dict. 6(2): 67, = Merthi.

Merd.—(Usually written Tebboo Merd, sometimes spelled Mird): = Crystalina, Stubbs, Deerr. The name probably a corruption of Meera, Deerr (in lit. 5/25–21).

Merkuli.—India, Bengal (Chapman) Watt's Dict. 6(2): 60.

Merthi.—North India, Barnes, = Merati, Watt's Dict. 6(2): 67; Int. Sug. Jour., 23: 661, 1921. Pansahi class, strongly frost resistant, recommended in making crosses for hardiness; introduced from United Provinces, India, by U. S. Dept. of Agr. as SPI 33243, Mch., 23, 1912. In Cuba has been identified as = Uba de Natal, but probably on insufficient study. It certainly closely resembles Uba.

Mesangan.—Panjab, India, Barber, Studies, 3.

Mestiza.—Argentina, from Brazil, Zerban, 1910; Philippines, Agr. Rev. 6: 618, 1913.

Mewa.—Bombay, India, = Kajuria, Knight.

Mexican Bamboo.— = Crystalina, Deerr.

Mexican Ribbon.— = Louisiana Ribbon, John Diamond (= Striped Preanger).

Mexican Striped. = Red Ribbon, Stubbs (= Striped Preanger).

Mia Giang.—Java, from Cochin China, Geerligs, West-Java, Med. 27.

Mia-lan.—Cochin China, Sagot, 326.

Mia May.—Java, from Cochin China, Geerligs, West-Java, Med. 27.

Mia Toa Dja.—Java, from Cochin China, Geerligs, West-Java, Med. 27.

Mia Voy.—Cochin China, = Elephant, The Sugar Cane, 4: 605, 1872.

Migao.—New Caledonia, Vieillard, 1863, Sagot, 345.

Mignonne.—Mauritius, from New Caledonia, 1870, Agr. Bull. 2: 11, 1916; Boname, 1895, 1898–9. The cane from which it is claimed Lousier is a sport.

Mignonne Rayée.—Mauritius and Réunion, from New Caledonia (Detail), Sagot, 328; Guadaloupe; Bonamc, 1888; Réunion, Colson, 1905.

Mignonne Rouge.—Mauritius, Boname, 1898–9.

Mindoro.—Philippines, Mendiola, Identification Key, Plant News, 3(1), Jan., 1922; Facts About Sugar, 5/18–25, p. 379.

Mingka.— = POJ 36M. (See list of canes in Arlington greenhouses, in lit.) (Introduced from Formosa by U. S. Dept. Agr.)

Mirah Rubia.—Queensland, from Java, 1878, Easterby (a misprint for Merah).

Mirati.—India, Watt's Dict. 6(2): 66.

Mittan.—India, Watt's Dict. 6(2): 62.

M-ma.—Mauritius, from New Caledonia (Lavignac), Horne, 1869; Queensland, from So. Sea Islands, 1874, Easterby.

M-Merai.—Mauritius, from New Caledonia (Lavignac), Horne, 1869; Queensland, from So. Sea Islands, 1874, Easterby.

Mobona.—Louisiana, Agee.

Moene.—New Caledonia, Vieillard, 1868, Sagot, 347.

Moerei.—Java, from Sumatra, Wakker, 1896.

Moindiene.—New Caledonia, Vieillard, 1863, Sagot, 347.

Moir's White.—Hawaii, Eckert, Bull. 17, 1906.

Mojora.—Assam, Barber, Studies, 3.

Molle.—Argentina, from Brazil, Zerban, 1910 (see Morada del Pais).

Momcha.—India, Clark and Hadi.

Monanion.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.

Mona Seedling.—Jamaica, Rept. Sug. Sta. 2:57, 1908.

Monjet.—Java, Soltwedel, Fig. 13, a slender, dark-purple cane with surface cracks but no bloom, nodes slightly constricted, growth ring yellowish, rather broad, rudimentary roots large, in 3–4 broken rows, buds broadly ovate, small, not exceeding the growth ring. Quite distinct from Black Cheribon to which it is often referred; Gonsalves (written Teboe Mouget) = Black Cheribon.

Mont Blanc.—Jamaica, MacFadyen, = Violet Cane (Black Cheribon), = Crystalina, Deerr; Barbados, Rept. 1905–7:98.

Mont Eagle Seedling.—Jamaica, Rept Sug. Sta. 2:64, 1908.

Monte Alegre.—Brazil, Sao Paulo, Bull. 16:938, 1915.

Moohana.—Australia, from New Guinea, Tryon, La Plant. 8/29–25, p. 176.

Moo Moo.—Queensland, from New Guinea, Maxwell, 1903–4.

Moomooboku.—Queensland, from New Guinea, 1895, Easterby.

Moore's Purple.—Queensland, from Mauritius, 1878, Easterby, N. S. Wales, planting permitted by Colonial Sugar Co. Int. Sug. Jour., 1:506, 1899; resistant to gum disease, E. F. Smith; = Black Cheribon, Deerr.

Mootora.—Cent. India, Watt's Dict. 6(2):69.

Moracabo.—Madras, India, Watt's Dict. 6(2):76 (see Maracabo).

Morada.—Spanish America, = Black Cheribon, Deerr; Cuba, often popularly used for Cavengerie.

Morada del Brazil.—Argentina, from Brazil, Zerban, 1910. Very similar to Louisier de Mauricio, Kissaman, Roxa, Oscura de Sao Simao, and Louisier (probably all = Cavengerie).

Morada del Pais.—Argentina, from Brazil, Zerban, 1910. Much resembling this are Listada Julien, Molle, and Fistula de Sao Samao, probably all = Louisiana Purple.

Morel Cane.—Louisiana, John Diamond, 1886, = Murillo, = Mexican Ribbon (= Striped Preanger).

Morris.—Demerara, Harrison and Jenman. Nearly identical with Meligeli, brought from Barbados in 1889, Harrison (in lit.).

Moueoute.—New Caledonia, Vieillard, 1863, Sagot, 347.

Mouget.—Java (see Monjet).

Mouptora.—India, Watt's Dict. 6(2): 70.

Mozambique.—Java, from Malacca, Wakker, 1896 (see Canne Mozambique, = Djamprik).

MP.—(Initials with numbers): Seedlings grown in Mauritius by G. Perromat, = Paromat Seedlings. The series began in 1891. Many are supposed to be seedlings of Penang.

MQ.—(Initials with numbers): A series of natural seedlings found on a sandy river bank near Port Douglas, Easterby, Bull. 2, 1926.

Muggurwar.—Cent. India, Watt's Dict. 6(2): 69.

Munggee.—India, Watt's Dict. 6(2): 69, also Mungia and Mungija.

Mungo.—Orissa, India, is gaining ground here, Int. Sug. Jour., May, 1923, p. 243.

Mungo Beheea.—Java, from British India, Kobus, Med. 48, 1893.

Mungo Shahjahanpore.—Java, from British India, Kobus, Med. 48, 1893.

Mungoo.—India, Papers, Sugar, 1822, Watt's Dict. 6(2): 57.

Munk.—India, Watt's Dict. 6(2): 70.

Muntok.—Java, from Banca, Deerr; resistant to sereh, E. F. Smith, Bact. 3: 77, also Geerligs.

Muntok Zwart.—Java, Kobus, Med. 6, 1893.

Murra (Tabor Murra).—Queensland, from Java, prior to 1878, Easterby, Bull. 2, 1926.

Mutaira.—India, Watt's Dict. 6(2): 70.

Mutua.—India, Watt's Dict. 6(2): 69.

Mysore Java.—Mysore, Coleman, Econ. Jour., 6(4), Apr., 1920.

Naanal.—India, Barber, Studies, 2, 3 (see Nanal).

Naga.—Mauritius, from New Caledonia (Lavignac), Horne, 1869; Jamaica, from Mauritius, 1882, D. Morris; Louisiana, from Jamaica, Stubbs, Agee; Demerara, = Keening, Harrison and Jenman.

Naga B.— = Crystalina, Deerr.

Nagamie.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.

Nagapoury.—Jamaica, from Mauritius, 1882, D. Morris, = Naga? or Keening? Bowery, Bull. 4 (U. S.): 227, 1897.

Nagori.—Behar, India, a group of canes of narrow diameter with swollen nodes, that thrive in swampy land, often growing in same field with rice, Int. Sug. Jour., Feb., 1925, p. 81, and Oct., 1925, p. 532.

Nain.—Jamaica, from Mauritius, 1882, D. Morris; = Mani, Bowery, Bull. 4(U. S.): 227, 1897; Java, from Malacca, Wakker, 1896.

Nainan.—Madras, India, from Mauritius, Watt's Dict. 6(2): 76.

Namala.—Madras, India, Benson, Int. Sug. Jour., 2: 469, 471, 1900.

Naman.—India, Barber, Studies, 2.

Nanal.—Madras, India, Deerr (see Naanal).

Nanemo.—Queensland, from New Guinea, 1914, as 14 NG, also C. S. R. Co., No. 226, Easterby, Bull. 2, 1926.

Narem.—Queensland, from New Guinea, 1914, as 14 NG, No. 125, C. S. R. Co., Easterby, Bull. 2, 1926.

Nargori.—India, Barnes, Taylor, Woodhouse.

Natal.—Mauritius, Boname, 1896, 1898–9.

Nave.—Queensland, from New Guinea, 1895, = Mave, Easterby.

Neengon.—New Caledonia, Vieillard, 1863, Sagot, 345.

Negros.—Philippines, Agr. Rev. 618, 1913.

Negros Purple.—Philippines, Agr. Rev. 6:618, 1913; H. Atherton Lee (in lit. 6/17–21), a color variant of Luzon White, = Negros, Purple Native, Black Manila, Inalmon; a standard kind, Mendiola, Phil Farmer, Aug., 1920, p. 63; Argentina, from the Philippines, Rev. Tuc. 9(1):14, 1918.

Neligeli.—Demerara, Harrison, Rept. 1894–5 (see Meligeli).

Neula.—India, Watt's Dict. 6(2):62.

Newar.—India, Papers—Sugar (1792), 1822; Watt's Dict. 6(2):57.

New Caledonian Queen.—Mauritius, formerly known as Kavenger, Boname, Rept. 1895, 1898–9. (The name at least is new.)

New Guinea.—Argentina, from Philippines, Rev. Tuc. 9(1):14, 1918.

NG.—(Initials with numbers): Canes imported to Queensland from New Guinea about 1895.

N'ga-Brou.—New Caledonia, Breslau, 1884, Sagot, 332.

N'ga-Cari.—New Caledonia, Breslau, 1884, Sagot, 332.

N'gada.—New Caledonia, Breslau, 1884, Sagot, 331.

N'gala.—New Caledonia, Vieillard, 1863, Sagot, 347.

N'ga-mie—New Caledonia, Breslau, 1884, Sagot, 332.

N'ga Opa.—New Caledonia, Breslau, 1884, Sagot, 332.

Nia do Quoin Mie.—New Caledonia, Breslau, 1884, Sagot, 334.

Nia do Quoin Pa.—New Caledonia, Breslau, 1884, Sagot, 334.

Nichols.—Louisiana, a light-striped bud sport, Stubbs; Queensland, from Louisiana, 1895, Easterby.

Niembla.—New Caledonia, Vieillard, 1863, Sagot, 346.

Nieuw Guinea Geel.—Java, Kobus, Med. 6, 1893.

Nieuw Guinea Gestreipt.—Java, Kobus, Med. 6, 1893.

Nieuw Guinea Rood.—Java, Kobus, Med. 6, 1893.

Nieuw Guinea Zwart.—Java, Kobus, Med. 6, 1893.

Nigrita.—Cuba, a local name for a cane with purple leaves, probably = Djamprik.

Niliva.—Bombay, India, = Jowari White, Knight.

Nipa.—Java, from Sumatra, Wakker, 1896.

Nipa Telok Betong.—Java, Kobus, Med. 6, 1893.

Njamplong.—Mauritius, Horne, 1869; Java, Geerligs, West-Java, Med. 27.

Njamplong de Sourabaija.—Java, Krajenbrink, The Sugar Cane, 2:190, 1870.

Nora Tava.—Demerara, = Keni Keni, Harrison and Jenman.

Norman.—Jamaica, Bot. Bull. 2; Demerara, = Mani, Harrison and Jenman; Louisiana, from Jamaica, Stubbs, Agee.

Numa.— = Black Cheribon, Deerr.

Nyamplong.—Mauritius, Horne, 1869 (see Njamplong).

Obo.—Queensland, from New Guinea, 1914, as 14 NG, No. 188, C. S. R. Co., = Badila, Easterby, Bull. 2, 1926.

Oedang.—Java, from Amboina and Sumatra, Wakker, 1896; Soltwedel, Fig. 21, a medium-stout green and purple striped cane with barrel-shaped internodes and strongly constricted nodes, growth ring yellowish or brownish, bud ovate, margin uniform.

Ohia.—Louisiana, from Hawaii, Stubbs, Agee, = Honuaula, = Papaa.

Oiboku.—Queensland, from New Guinea, Maxwell, Rept. 1903–4.

Oiva.—Queensland, from New Guinea, 1895, Maxwell, Easterby; N. S. Wales, planting permitted by Colonial Sugar Co., Int. Sug. Jour. 1:506, 1899.

Oliana.—Hawaii, Deerr, Rock.

Ombonoutou.—New Caledonia, Breslau, 1884, Sagot, 337.

Onata.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.

Onboonontona.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.

Ook.—India Papers—Sugar, Ap. 1:142, 1822.

Oramboo.—Queensland, from New Guiana, 1914, as 14 NG No. 190, C. S. R. Co., also as 230 and 233. Differs from Ormboo, Easterby, Bull. 2, 1926.

Oraya.—Queensland, from New Guinea, 1895, Easterby.

Orcassi.—Queensland, from New Guinea, 1914, as 14 NG No. 158, Easterby, Bull. 2, 1926.

Ormboo.—Queensland, from New Guinea, 1914, as 14 NG No. 132, Easterby Bull. 2, 1926, differs from Oramboo.

Ornu.—Queensland, from New Guinea, 1914, as 14 NG No. 133 C. S. R. Co., Easterby, Bull. 2, 1926.

Otaheite.—Louisiana and Florida, Stillman, 1833; Louisiana, Fleischman, with colored plate, 1848; Jamaica, Bligh, 1793, Deerr, = Bamboo II, Bourbon, Lahaina, Lousier, Portii, Singapore. Possibly more than one variety is included (see Oudinot). In Jamaica, Bot. Bull. 2, = Crystalina, Deerr; in Réunion, = Black Cheribon, Deerr; in Queensland, = Chinese, Davidson.

Otaheite Ribbon.—Wray, = Striped Tanna, Deerr (but in lit. 5/25–21, Deerr comments Wray was very insistent that this = Transparent, and the name Tanna only appeared in the eighties or later).

Otaheite with Purple Bands.—Evans, The Sugar Planter's Manual, p. 37 (probably = Striped Preanger).

Otamite.—Mauritius, Boname, 1895, badly attacked by gum disease, 1896, 1898–9; Queensland, Easterby (this is clearly = Cavengirie but the note on gum disease by Boname indicates that his cane was different since Cavengirie is resistant to gum disease). See Otomato, Onatemite, etc.

Otang.—Java, from Sumatra, Wakker, 1896.

Otomato.—Philippines, from Australia, Hines, Agr. Rev. 8:157, 1915. (The description indicates Cavengirie, probably a misprint for Otamite, which see); Philippines, Mendiola, Identification Key, Sug. News 3(1), Jan., 1922 = Louisiana Purple.

Ouale.—New Caledonia, Vieillard, 1863, Sagot, 347.

Ouane.—New Caledonia, Vieillard, 1863, Sagot, 347.

Outa.—Mauritius, from New Caledonia (Lavignac), Horne, 1869.

Ouatamite.—New Caledonia, Breslau, 1884, Sagot, 343. (Probably the original form for Otamite. It is described as wine red with black bands, thus indicating Cavengirie.)

Oubounoutoo.—New Caledonia, Caldwell, The Sugar Cane, 3:208, 1871.

Oudinot.—Hawaii, Deerr, and Eckert, Bull. 26:8, 1908, = Cuban, = Keni Keni (a native name meaning numerous). One of the canes brought to Hawaii from Otaheite in 1854 by Capt. Pardon Edwards, the other being Lahaina.

Oue Merou.—New Caledonia, Breslau, 1884, Sagot, 336.

Oue Mie.—New Caledonia, Breslau, 1884, Sagot, 336.

Ouenebail.—New Caledonia, Vieillard, 1863, Sagot, 347.

Ouen Mangia.—New Caledonia, Vieillard, 1863, Sagot, 348.

Ouenoupoudendate.—New Caledonia, Vieillard, 1863, Sagot, 346.

Ouentouta.—New Caledonia, Breslau, 1884, Sagot, 324.

Ouepa.—Queensland from So. Sea Islands, 1874, Easterby.

Oueron.—New Caledonia, Vieillard, 1863, Sagot, 346.

Oura.—Society Islands, Cruzent, 1860.

Ouremendo.—New Caledonia, Breslau, 1884, Sagot, 342.

Outamite.—Queensland, from So. Sea Islands, 1874, Easterby (see Otamite, Ouatamite, etc.).

Paak Che.—List of Canes in Arlington Greenhouse, U. S. Dept. Agr. (in lit. 6/21–26).

Pachrangi.—India, Watt's Dict. 6(2):67.

Padang.—Java, Kobus, Med. 6, 1893.

Pahdhra.—Bombay, = Bundya, Watt's Dict. 6(2):73.

Paiambou.—New Caledonia, Vieillard, 1863, Sagot, 346.

Paieme.—New Caledonia, Vieillard, 1863, Sagot, 348.

Painwara.—India, Bengal, Chapman, Watt's Dict. 6(2):60.

Palania.—Hawaii, Deerr.

Palembang.—Java, Kobus, Med. 6, 1893.

Palfrey Cane.—Louisiana, John Diamond, 1888, = Crystalina.

Palmyra.—Queensland, = Goi Goi, = NG 42, Easterby.

Palo Rojo.—Porto Rico, Stahl, Revist. Agr. 1887, p. 174, introduced later than 1878; Lopez Tuero, = Bois Rouge.

Palo Rojo Claro.—Porto Rico, Stahl, Revist. Agr. 1887, p. 174, introduced later than 1878, = Bois Rouge Blonde.

Pampanga Purple.—Philippines, a standard kind, Mendiola, Phil Farmer, Aug., 1920, p. 63 (= Negros Purple).

Pampanga Red.—Philippines, H. Atherton Lee (in lit. 6/7–21), = Red Manila, Rood Manila, Philippines Rouge, a color variant of Luzon White.

Pampanga White.—Philippines, Facts About Sugar, 5/18–25, p. 379, Mendiola, Identification Key (= Luzon White).

Pamplemousses.—(With numbers): A series of seedlings grown in Mauritius. A number have been brought to Queensland.

Panache.—Louisiana, from Jamaica, Stubbs, Agee, = Crystalina, Deerr.

Pandaan Poetih.—Java, Kobus, Med. 6, 1893.

Pandia.—India, Watt's Dict. 6(2):62 (see Paunda, Pundia, etc.).

Pangka.—Java, Ledeboer, Med. 4:452, 1917.

Pansahi.—India, Watt's Dict. 6(2):60, Barber, Studies, 2, Taylor, Woodhouse (as Panshaki). Used as a class name by Barber for the group also known as Chinese canes, the *Saccharum sinense* Roxburgh of which Uba is best known. They are not native in North India.

Pansari.—India, Clark and Hadi.

Pa-o-le.—Demerara, = Altamattii, Purple Mauritius, Cavengerie, Giant Claret, Harrison and Jenman (see Po-a-ole).

Papaa.—Hawaii, Deerr, Rock; Louisiana, from Hawaii, = Ohia, = Honuala, Stubbs, Deerr.

Papaliva.—Queensland, from Java, 1878, Easterby.

Pappoa.—Louisiana, from Cuba, Agee, Bull. 127:16, 1911.

Papua.—Java, from Java, Wakker, 1896.

Pariah.—Mauritius, Duval; Queensland, = Meera, Davidson.

Parinaribo.—Java, Kobus, Med. 6, 1893.

Parrah.—Queensland, from Mauritius, 1878, Easterby.

Passaeraewan.—Mauritius, from Java, Horne, 1869.

Pasar.—Mauritius, from Java, Horne, 1869; Queensland, from Java, 1874, Easterby.

Passin.—Java, from Sumatra, Wakker, 1896.

Patarki Mango.—India, Clark and Hadi, Barnes.

Pattapatti.—Mysore, India, Agr. Calender, 1915; Coleman Econ. Jour., 6(4), Apr., 1920. A striped variety supposed to have been introduced 150 years ago from Madras. Two-thirds to three-fourths of the cane in this state is of this kind.

Patu.—Tahití, Dr. Bennett, The Sugar Cane, 6:593, 1874.

Paunda.—India, Watt's Dict. 6(2):60. A class name proposed by Hadi for the stout introduced canes using Ukh and Ganna for slender and intermediate canes, Deerr. In appendix, p. 611, Deerr says not necessarily exotic to India. This name of Pundya occurs in a work written in the thirteenth century which speaks of the Paunda cane of the Malabar Coast, the like of which is not found in India. It is still grown extensively in the Deccan near the Malabar Coast and is of the best South Pacific type. It somewhat resembles Otaheite but is certainly distinct from it. It is known to afford a red and

yellow sport. (In a letter from Bombay, dated Jan. 1, 1921, he says "Paunda or Pundia is badly mixed. The cultivations I have seen contain five or six types. Otaheite is represented but the dominant type is unfamiliar to me.")

Paungdi.—India, Papers—Sugar, 3d, Ap. 35, 1822.

Paunri.—India, Taylor, Woodhouse.

Pauole.—Hawaii, = Cavengerie Deerr (See Po-a-ole).

Pena (Penang).—Bahia, Brazil, The Sugar Cane, 22:483, 1890.

Penabar.—Java, from Sumatra, Wakker, 1896.

Penang.—Mauritius, from Java, 1850, Dept. Agr. Bull. 2:11, 1916; Queensland, from Mauritius, 1878, Easterby, = Salangore, Davidson, Deerr. (In Porto Rico the name is used for a cane closely resembling what is there known as Bamboo Blanca.)

Perromat.—(With numbers): A series of canes produced in Mauritius. Some of them have gone to Queensland.

Peru.—(With numbers): Argentina, Cross, Facts About Sugar, 5/23–25, p. 495. Susceptible to frost and mosaic.

Petite Senneville.—Mauritius, Agr. Bull. 2:5, 7, 1916, = Improved MP 133; Queensland, from Mauritius, 1901, Easterby.

Philippine Blanche.—Mauritius, Boname, 1898–9 (= Luzon White).

Philippine Rouge.—Mauritius, Boname, 1898–9 (= Pampanga Red).

Phusburi.—Bombay, India, = Fudburi, Knight.

PI.—(Initials with numbers): Seedlings in the Philippines by C. W. Hines, Agr. Rev. 10:32, 1917.

Piaverae.—Pacific Islands, Deerr.

Piavere.—Society Islands, Cruzent, 1860, = *Saccharum obscurum* Trin.

Pidiak.—New Caledonia, Vieillard, 1863, Sagot, 348.

Pilimai.—Hawaii, Eckert, Bull. 17:9, 1906.

Pinang.—Porto Rico, Stahl, Lopez Tuero; Réunion, Colson (see Penang), = Salangore, Deerr. (The name is not so used in Porto Rico.)

Pine.—Jamaica, Bot. Bull. 2.

Pink Cane.—Queensland, from New Caledonia (Muir), Davidson, 1880.

Pink Ribbon.—Queensland, from New Caledonia, (Muir), Davidson, 1880, Easterby.

Pitu.—Brazil, Pernambuco, Bull. 3, = Roxa, = Listada, Gorkum, Weller, The Sugar Cane, 25:187, 1893; Demerara, Jour. Brit. Guian., 10:66, 1917.

PK.—(Initials with numbers): Java, Harreveld, Med. 4:1654, 1919.

Platnaiya.—India, Watt's Dict. 6(2):62.

Ploucaona.—New Caledonia, Breslau, 1884, Sagot, 335.

Po-a-ole.—Jamaica, from Mauritius, 1882, D. Morris; Louisiana, from Jamaica, Agee; Java, from Malacca, Wakker, 1896; Demerara, = Jamaica, = Barbados, = Purple Mauritius, Harrison and Jenman, = Cheribon, Deerr (see Pa-o-le, = Cavengirie).

Pobone.—New Caledonia, Vieillard, 1863, Sagot, 346.

Po d'ouro.—Campos, Brazil, Gerkum (see Poudre de Oro).

Poerbolinggo.—Java, from Java, Wakker, 1896.

Poetih.—Java, from Java, Timor, Amboina, Menado, and Sumatra, Wakker, 1896.

Poetii.—Brisbane Bot. Gar., from Java, The Sugar Cane, 2:104, 1870 (see Portii).

Poetri.—Java, from Sumatra, Wakker, 1896.

Poilote.—New Caledonia, Vieillard, 1863, Sagot, 345.

POJ.—(Initials with numbers): Seedlings grown at Proef. Station Oost-Java, the East Java Field Station at Pasoerocan. Many of the earlier ones by Kobus are crosses of the North Indian Chunnee on Black Cheribon. This was the first considerable attempt at combining the characters of widely different canes by crossing. These crosses are resistant to Sereh and to root disease and are tolerant of mosaic. Some of the later POJ series are based on Kassoer crosses, thus POJ 2714, 2725, and 2878 carry one-fourth of Kassoer blood combined with Black Cheribon, Red Fiji, and Black Borneo.

Pompey.—Queensland, Easterby, Bull. 2:29, 1926, = 7 R 429. Is planted on a field scale.

Ponda.—India, Watt's Dict. 6(2):69 (see Punda and Pundia, etc.).

Ponna.—(Also written Pona and Puna): India, grown all over the Punjab for eating, seldom used for sugar, The Sugar Cane, 15:644, 1883; Watt's Dict. 6(2):67.

Pooree.—India, Papers—Sugar (1792), 1822, West Indian planters are quoted as saying it is the same as the cane grown there. (A colored plate might pass for Creole but it is poorly drawn. See Puri.)

Poori.—India, Roxburgh, under *Saccharum officinarum.*

Poovan.—India, Barber, Studies, 2.

Poraya.—India, Taylor, Woodhouse.

Portier.—Louisiana, = Lahaina, = Keni Keni, considered distinct from Otaheite, Stubbs; from the Marquesas, Agee (see Portii, Poetii, etc.).

Portii.—Mauritius, from Java, Horne, 1869, a chalky gray cane; Hawaii, Deerr and Eckert, = Otaheite, Deerr. Deerr's latest opinion seems to be that it = Salangore (Cane Sug. 57). This would accord better with Horne's observation (see Poetih and Poetii).

Port Mackay.—Mauritius, from Queensland, 1869, Dept. Agr. Bull. 2:5, 1916; Boname, 1895, 1898–9; Réunion, a red cane (Delteil) Sagot, 330, Colson; Java, from Hawaii, Wakker, 1896; Brazil, locally known as Louzier, Purple Cane, Black Cane, etc., introduced to Pernambuco twenty years ago to combat gum disease, Int. Sug. Jour., 1:379, 1899; Sao Paulo, Sawyer, Gorkum, = Cavengerie, Deerr; Java, Kruger 145, a yellowish green cane with brown dots; Argentina, from Brazil, Zerban, 1910, a green cane. (Evidently two or more canes are mixed under this name. In Australia it seems always to have referred to Cavengirie.)

Port Mackay Noir.—Mauritius, Deerr; a black sport from Cavengerie, Boname, 1898–9 (see Cavengerie Negra).

Poteii.—Queensland, from Java, 1874, Easterby (see Portii, etc.).

Poudre Blanche.—Brazil, Sao Paulo, Sawyer, 1908; Argentina, from Brazil, Zerban, 1910.

Poudre d'Oro.—Brazil, Sao Paulo, Sawyer, 1908; Natal, The Sugar Cane, 9:322, 1877; Argentina, from Brazil, Zerban, 1910.

Poudre d'Or Rayée.—Mauritius and Réunion, from New Caledonia (Delteil) Sagot, 328; Guadeloupe, Boname, 1888.

Pounemate.—New Caledonia, Vieillard, 1863, Sagot, 345.

PR.—(Initials with numbers): Seedlings grown in Porto Rico. Numbers 1–200 were produced at the Federal Station at Mayaguez. These seem to have been all lost; those above 200 were produced at the Insular Station at Rio Piedras.

Prata.—Barbados, Rept. 1908, 10:55, 1911.

Preanger.—The name now used by Jeswiet for part of the canes formerly included under Cheribon. There are light, dark, and striped forms.

Preta.—Demerara, Jour. Brit. Guian., 10:66, 1917.

Pring.—Java, = White Cane, Kajenbrink, The Sugar Cane, 2:192, 1870.

PRM.—(Initials with numbers): Seedlings produced at the Federal Station at Mayaguez, Porto Rico.

Providence.—(With numbers): Demerara, Jour. Brit. Guian., 11:156, 1918.

Puaolle.—Mauritius, from Sandwich Islands, Horne, 1869; Hawaii, Rock. Bull. 2, 1913 (see Po-a-ole).

Pulvo de Oro.—Bahia, Brazil, The Sugar Cane, 22:483, 1890 (see Poudre d'Oro).

Punahia.—India (see Pundia).

Pundi.—India, Taylor.

Pundia.—Bombay, India, Watt's Dict. 6(2):74, a large white cane supposed to be two varieties, one indigenous and one imported from Mauritius (= Otaheite) Knight, Bull. 61, 1914, = Gubbi Rasdali (see Paunda, Pandia, etc.). Deerr (in lit. 5/25–21), "The Pundhia cane was established in the Deccan (= Malabar) as early as A.D. 1395. It is a tropical cane of the Otaheite type. The name means white."

Pundyabas.—Bombay, India, Watt's Dict. 6(2):73.

Pungdi.—India, Watt's Dict. 6(2):57.

Punri.—India, Bengal (Chapman), Watt's Dict. 6(2):60.

Punsaree.—Benares, India, Papers—Sugar, 1822.

Pupuha.—Louisiana, from Hawaii, Stubbs, Agee.

Purhea.—India, Watt's Dict. 6(2):70.

Puri.—India, Watt's Dict. 6(2):57; Bengal, illustrated by East India Co. in 1792, a soft yellow cane (see Poorce); Sabour, Taylor; Woodhouse; Java, from British India, Kobus, Med. 48, 1893; Wilbrink and Ledeboer, Med. 6:86, 1911; Van Derventer, Handb. 5:142, 1915; Behar,

India, one of the noble canes in fairly extensive cultivation South of the Ganges, Int. Sug. Jour., Oct., 1925, p. 532. = Creole, Deerr.

Purisave.—Benares, India, Watt's Dict. 6(2):57.

Purple Bamboo.— = Louisiana Purple, = Black Cheribon, Deerr.

Purple Cane.—Brazil, = Port Mackay (= Cavengerie).

Purple Cheribon.—Mauritius, = Cane Belonjet (= Black Cheribon).

Purple Elephant.—Louisiana, from Cochin China, Stubbs; from Hawaii, Agee.

Purple Jamaique.—Mauritius, Boname, 1896, 1898–9 (= Black Cheribon).

Purple Mauritius.— = Black Cheribon, Deerr.

Purple Native.—Philippines, Wakker, = Negros Purple.

Purple Otaheite.—Evans, The Sugar Planters' Manual 37, 1847, (= Black Cheribon).

Purple St. Louis.—N. S. Wales, Int. Sug. Jour., 1:506, 1899, Colonial Sugar Co. permits planting in certain districts.

Purple Striped.—Sagot 327 = Canne Rubinee d'Otahiti (= Striped Cheribon).

Purple Transparent.— = Black Cheribon, Deerr, Harrison and Jenman.

Purple Violet.—Wray, = Black Cheribon, Deerr.

Pusin.—Java, from Bovenlanden, Wakker, 1896.

Putih.—Kruger, 145 (see Poetih).

Putli Khajer.—India, Barber, Studies, 2, 3.

Putta Putti.—India, Paper—Sugar, 3d Ap.: 12, 1822; Watt's Dict. 6(2):72.

PWD.—(Initials with numbers): Java, Harreveld, Med. 12:1708, 1918.

Pyinmana Red.—Burma, Rept. Indian Sugar Committee, Int. Sug. Jour., Oct., 1921, p. 559.

Q.—(Initial with numbers): Seedlings grown in Queensland by the Acclimatization Soc., 1900 to 1907, Easterby.

Queensland.—Jamaica, Bot. Bull. 2; Bull. 4 (U. S.):227, 1897, Bowery, = Queensland Creole?

Queensland Cane.—Trinidad, = Badila.

Queensland Creole.—Barbados, Rept. 1905–7; 25, 1808; Demerara, = Black Cheribon, Harrison and Jenman.

Queensland White Bamboo.—Barbados, Rept. 1905–7:134, 1908.

R.—(Initial with numbers): Seedlings produced at Rarawai, Fiji.

Racha.—Formosa, Ishida, Sugar Sta. Bull. 1:42, 1920.

Radjih.—Java, from Java, Wakker, 1896.

Raileve.—New Caledonia, Breslau, 1884, Sagot, 339.

Raishmi.—Cent. India, Watt's Dict. 6(2):69.

Rajado.—Brazil, Sao Paulo, Sawyer, 1908 (Rayada?).

Rakoti.—Cent. India, Watt's Dict. 6(2):69.

Raksi.—India, United Prov. Barber, Studies, 3.

Raksida.—India, N. W. Prov., Watt's Dict. 6(2):62.

Ramrasdali.—India, Bombay, Knight = Kasbirya; Watt's Dict. 6(2):73.

Ramrasul.—India, Bombay, Watt's Dict. 6(2):74.

Ramui.—India, United Prov., Barber, Studies, 3.

Ranji-Kali.—India, Assam (Stack), Watt's Dict. 6(2):62.

Rapoe.—(Variously spelled Rapoche, Rapooh, Rappoe, Rappole, etc.): Usually taken to = Crystalina, but in Mauritius and Queensland it is a striped cane, probably Striped Cheribon. Soltwedel, Fig. 11, is a medium-diameter, ash-green cane with slight flush and heavy bloom, nodes slightly constricted, buds broadly oval, not shouldered. It would pass for Crystalina except for the buds but as usual these are carelessly drawn.

Rapooh Kiang.—Java, Soltwedel, Fig. 14, represents a medium-stout purple cane apparently with heavy bloom; nodes slightly constricted, growth ring yellow, very broad and conspicuous; buds broadly ovate-acuminate.

Rappoe Koening.—Mauritius, from Java, Horne, 1869; Hawaii, Deerr and Eckert.

Rappoe Maeda.—Mauritius, from Java, Horne, 1869; Hawaii, Deerr and Eckert.

Rappoe Posai.—Queensland, from Java, 1878, Easterby.

Rappoh Malda.—Deerr, p. 53.

Rasal.—India, Bombay, Watt's Dict. 6(2):73.

Rasdale.—Bombay, India, Knight.

Rastale.—Mysore, Coleman, Mysore Econ. Jour., 6(4), Apr., 1920. A soft white cane, extensively grown in the Chitaldung district.

Rat.—Mauritius, Boname, 1898–9.

Rat-Gros-Ventre.—Réunion, Colson, 1905.

Rattan.—Queensland, from Java, 1874, Easterby.

Raungda.—India, Papers—Sugar, 3d Ap.:35, 1822; Watt's Dict. 6(2):57.

Ravannais.—Argentina, from Brazil, Zerban, 1910, = Rayada del Pais, Rev. Tuc. 9:132.

Raweh.—Java, Med. Oost-Java, 7:4.

Rayada.—All Spanish American countries, = Striped Preanger.

Rayada del Pais.—Argentina, from Brazil, Zerban, 1910, = Ravannais, = Yunseao, = Cayana Rosa, = Riscada de Sta. Barbara, = Red Ribbon (Striped Preanger).

Red Assam.—Bengal, India, Wray; N. S. Wales, from India, The Sugar Cane, 14:50, 1882.

Red Baruma.—Queensland, from New Guinea, as No. 47, Easterby.

Red Bombay.—India, Bengal (Chapman) Watt's Dict. 6(2):60; Taylor, Woodhouse = Bombay.

Red Borneo.—Kruger 141, = Tebu Merah Borneo, = Juts Lumar-rohr.

Red Cane.—Georgia, Florida, = Louisiana Purple, Yoder, U. S. Dept. Agr. Bull. 486.

Red Cane of Batavia.—Java, Krajenbrink, The Sugar Cane, 2:192, 1820 (probably = Black Cheribon).

Red Cuttarah.—Mauritius, Horne, 1869.

Red Java.—Sabour, India, Taylor; Woodhouse. Probably identical with Red Tanna (Black Tanna).

Red Joeno.—Java, from Java, Wakker, 1896; Kobus, Med. 6, 1893.

Red Lousier.—Mauritius, Agr. Dept. Bull. 2:11, 1916, a red sport from Lousier (Otaheite).

Red Manila.—Java, Deerr, nodes swollen (= Pampanga Red).

Red Mappo.—Queensland, from Mauritius, 1878, Easterby; Java, from Australia, Wakker, 1896.

Red Mauritius.—India, Barber, Studies, 2; Knight; Taylor, Woodhouse; in India always = Cavengerie, Deerr (in lit.); Mysore, Coleman, Econ. Jour., 6(4), Apr., 1920. Introduced from the Samalkota Agr. Sta. in 1906. It is the most vigorous and highest-yielding cane we have found; has revived the sugar industry in the Godarari district.

Red Panda.—India, Bengal (Chapman), from Mauritius, Watt's Dict. 6(2):60.

Red Ribbon.—The numerous citations usually = Striped Preanger. Occasionally Striped Tanna is probably intended. The Red Ribbon of the Brisbane Bot. Gar. from New Caledonia was neither of these if Hill's description of "leaves with bristly hairs at base" is correctly understood to indicate a vestiture on the sheaths.

Red Ribbon of Batavia.—Mauritius, Bouton (= Striped Tanna?).

Red Rose Ribbon.—Jamaica, Bull. 4:227, 1897, = Red Ribbon.

Red Striped Lousier.—Mauritius, Agr. Dept. Bull. 2:11, 1916. Originated as a sport from Lousier (= Horne).

Red Tanna.—India, Taylor, Woodhouse, = Red Java (Black Tanna).

Reddish White.—Formosa, Ishida, Sug. Sta. Bull. 1:44, 1920.

Reguard.—Mauritius, Boname, 1895.

Reina.—Bahia, Brazil, The Sugar Cane, 22:483, 1890 (see Reine).

Reina de Caledonia.—Porto Rico, Stahl, Lopez Tuero (see Caledonian Queen).

Reine.—Mauritius, Boname, 1896, 1898–9; Argentina, from Brazil, Zerban, 1910.

Reonda.—India, Papers—Sugar, 1822; Watt's Dict. 6(2):61.

Reongra.—India, Watt's Dict. 6(2):60.

Reonra.—India, Watt's Dict. 6(2):62.

Reora of Benareo.—North India, Barnes; Clark and Hadi (as Reori).

Reora of Gorakhpar.—India, Clark and Hadi.

Restali.—India, Papers—Sugar, Ap. 2:12, 1822; Madras, = Striped Cheribon?, Deerr.

Retrench.—(With numbers): Trinidad, = Hill's Seedling.

Rheora.—India, Taylor, Woodhouse (see Reora); Behar, India. A cane of the Mungo group, Hemja, Bhurli, and Rheora are very close and the names are interchangeable from district to district. They are described by Barber as of dwarf bushy habit. The dwarfness disap-

pears under good conditions but the bushy habit is pronounced when young. Medium maturity; Int. Sug. Jour., Oct., 1925, p. 532.

Rhi.—Mauritius, from New Caledonia (Lavignac), Horne, 1869; Queensland, from So. Sea Islands, 1874, Easterby.

Riat Tengang.—Java, from Borneo, Wakker, 1896.

Ribbon.—As usually used = Striped Preanger.

Riman.—Java, from Sumatra, Wakker, 1896.

Rimon.—Java, from Bovenlanden, Wakker, 1896.

Rinaio.—Mauritius, from New Caledonia (Lavignae), Horne, 1869.

Rin-kin.— = Red Cane, Formosa, Ishida, Sug. Sta. Bull. 1:42, 1920.

Riscada.—Brazil, Sao Paulo Bot. Agr. 16:731, 1915; Argentina, from Brazil, Zerban, 1910.

Riscada de Sta. Barbara.—Argentina, from Brazil, Zerban, 1910 (see Rayada del Pais).

River from St. Andrews.—Barbados, Rept. 1907–9:33, 1910.

River from Sta. Lucia.—Barbados, Rept. 1907–9:33 1910.

Rocha.—South Africa, from Formosa, Choles.

Rock Hall.—Barbados, West Ind. Bull. 2:26, 1901; St. Kitts, West Ind. Bull. 8:36, 1907.

Roixa.—Brazil, = Listrada de Amarillo, = Violacea, Moreira, 1876 (see Roxa).

Roixa de Folha Roixa.—Brazil Moreira, 1876.

Roja de Martinica.—Brazil, Weller, The Sugar Cane, 25:1871. 1893.

Rood.—Java, from Dutch New Guinea, Wakker, 1896.

Rood Ceram.—Java, Wilbrink and Ledeboer, Med. 6:86, 1911, Van Harreveld.

Rood Duitsch Nieuw Guinea.—Java, Jeswiet. Med. Deel 6(13):400, 1916 with full desc.

Rood Egyptisch.—List of canes in Arlington Green houses (in lit. 6/21–26). (As seen at Canal Point, Fla., seems to be true Black Cheribon.)

Rood Keong.—Java, Geerligs, Med. West Java, 27.

Rood Manila.—Java, from the Philippines, 1886, Van Derventer, Handb. 5:149, 1915 (= Pampanga Red).

Rood Raphoh.—Java, from Bagalen, Wakker, 1896.

Rood Shamshara.—Java, from Bombay, Kobus, Med. 48, 1893.

Rosa.—Brazil, Bahia, The Sugar Cane 22:483, 1890, Sao Paulo, Bot. Agr. 16:727, 1915; Argentina, from Brazil, Zerban, 1910; Barbados, Rept. 1908–10:55, 1911; Demarara, Jour., Brit. Guian., 10:66, 1917.

Rosa de Sao Samao.—Argentina, from Brazil, Zerban, 1910.

Rosa Morada.—Porto Rico, from New Caledonia, Stahl, Lopez Tuero.

Rose Bamboo.—Hawaii, Queensland, and most other citations = Crystalina. In Porto Rico, by some error, Yellow Caledonia was first distributed as Rose Bamboo.

Rose Diard.—Queensland, from Mauritius, Davidson, 1880. The Diard

canes are supposed to = Cheribon but Davidson's description gives "cane itch strong." Evidently not a Cheribon cane.

Rosita.—Porto Rico, a popular name for Cavengirie.

Rotan.—Java, from Amboina, Wakker, 1896; Soltwedel, Fig. 18, is a medium-slender green and yellow, striped cane; internodes long, slightly enlarged below furrow conspicuous; nodes constricted above the leaf scar; growth ring broad, of 2 or 3 colored bands; buds narrowly ovate.

Rotan Poetih.—Java, from Amboina, Wakker, 1896.

Rotten Idjo.—Java, Van Derventer, Handb. 5:151, 1915.

Rouxada.—Brazil, = Vermehla, Deerr, 49.

Roxa.—Brazil, Sao Paulo, Sawyer, 1908; Argentina, from Brazil, Zerban, 1910 (see Roixa).

Roxa de Sta. Barbara.—Argentina, from Brazil, Zerban, 1910.

Roxa de Sao Simao.—Argentina, from Brazil, Zerban, 1910 (see Morada del Pais).

Roxa Louzier.—Brazil, from Mauritius, Deerr.

Roxa Oscura de Sao Simao.—Argentina, from Brazil, Zerban, 1910, = Morada del Brazil, = Cavengirie.

Roxina.—Brazil, = Bronzeada, Deerr.

RP.—(Initials with numbers): Demerara, Jour., Brit. Guian., 11:157, 1918; Mauritius, from Demerara, Bull. 20:7, 1920, raised by a planter in Demerara; Queensland, from Mauritius, Bull. 2, 1926, Easterby.

Rubinee.—Guadaloupe, Sta. Rept. 1922–3 (see Canne Rubinee, = Striped Cheribon).

Ruckkree.—Java, from British India, Kobus, Med. 48, 1893; Wilbrink and Ledeboer, Med. 6:86, 1911; Van Derventer, Handb. 5:141, 1915.

Rurutu.—Pacific Islands, Deerr; Society Islands, Cruzent, 1860, Simmons Trop. Agr., 1877.

Russell.—Demerara, Harrison and Jenman.

Rutu.—Tahiti, Bennett, The Sugar Cane 6:593, 1874 (see Rurutu).

Saccharum.—The botanical generic name for sugar cane.

Saccharum atrorubens.—To Ute, Deerr (= Djamprik).

Saccharum Barberi Jeswiet.—Archief. 12, 1925, = Chunnee, etc.

Saccharum fasciolatum Tussac.—Page 25, Fig. 4, Jamaica, = Canne Rubinee (Striped Cheribon).

Saccharum Edule Hassk.— = Troeboe, Java.

Saccharum fragile Cruzant.—Simmons Trop. Agr., 1877, = Irimatu.

Saccharum obscurum Trin.—Cruzant, 1860, = Piavere.

Saccharum officinarum L.— = The thick tropical canes, the "noble canes."

Saccharum officinarum elongatum Bouton.—1863, = Canne Blanche (= Otaheite).

Saccharum officinarum vittatum Bouton.—1863, = Canne Guingham (= Striped Cheribon).

Saccharum sinense Roxb.— = The Chinese canes, = the Pansahi group, Barber.

Saccharum spontaneum L.— = The wild cane of India and the East Indies. = Glagah, Java; = Kahi, India; = Talahib, Philippines.

Saccharum Soltwedeli, Kobus.— = Glonggong, a wild cane in Java with only one row of rudimentary roots.

Saccharum violaceum Tussac.—1808, probably = Black Cheribon.

Saccharum violaceum album Bouton.—1863, = Canne du Pays (Mauritius).

Saccharum violaceum nigrum Bouton.—1863, = Canne Mozambique (= Djamprik).

Saccharum violaceum purpureum Bouton.—1863.

Saccharum violaceum spadeceum Bouton.—1863.

Sacuri.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison and Jenman, = Lakona; Louisiana, from Jamaica, Stubbs; Java, from Malacca, Wakker, 1896. (All references trace to Jamaica where the name seems to have originated. See Securi and Sinuri.)

Saeoni.—Porto Rico, Stahl., Rev. Agr., 1887, p. 174, introduced later than 1878.

Safaid.—India, Watt's Dict. 6(2); 69.

Sagari.—India, Watt's Dict. 6(2): 72.

Saguo.—Philippines, Wakker, Sug. Ind. Isl. Negros 77.

Saharanpieri.—India, Watt's Dict. 6(2): 67, = Saharri, = Dhaulu.

Sahranpur Black.—Queensland, from India, 1923. Easterby Bull. 2, 1926.

Saigon.—Queensland from Singapore, 1880, Easterby.

St. Aubin.—(With numbers): Mauritius, Bull. 20 and 23.

Salah.—Java, from Malacca, Wakker, 1896.

Salangor.—Straits Settlements, Wray. (A well-marked variety widely discussed in the literature), = Portii, Tebboo Bettong Barabou, Tebboo Capor, Penang (or Pinang), Mauritius, and Brazil (not Porto Rico), Chinese (Bourbon), White Mauritius, Green Transparent, Chalk cane, Canne Rocha. The two canes introduced into Trinidad and named by Purdie Green and Violet Salangore do not seem connected with this variety, Deerr, 56.

Salangor Blanca.—Porti Rico, Stahl, = Belogue Blanco, introduced later than 1878, Rev. Agr. 1887, p. 174. (Probably the true Salangor which exists in Porto Rico.)

Salangor Palmeira.—Bahia, Brazil, The Sugar Cane 22: 483, 1890.

Salangor Rayada.—Porto Rico, Stahl, = Belugue Rayada; introduced later than 1878, Rev. Agr., 1887, 174 (= Striped Cheribon ?).

Salangor Roja.—Porto Rico, Stahl, = Belugue Rojo, much like Cavengirie but lacks the stripes; introduced later than 1878, Rev. Agr., 1887, p. 174 (= Cavengirie Rojo).

Samoan.—Java, from Malacca, Wakker, 1896.

Samsara.—Bengal, India, Agr. Inst. Pasa. Bull. 83:27, 1919. Demerara, West Ind. Bull. 5:336, 1905 (see Somsarrah and Shamshara) (= Otaheite).

Samuri.—Jamaica, from Mauritius, 1882, D. Morris; the favorite kind in Fiji, The Sugar Cane 17:153, 1885; Demerara, Harrison and Jenman; Java, from Malacca, Wakker, 1896 (see Sacuri).

Sanacki.—North India, Barnes.

Sanbelli.—Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920.

Sandwich.—Java, Geerligs, Med. West Java, 27,

Sangre de Toro.—Porto Rico, local name, = Cavengirie Rojo.

Sannabile.—Bombay, India, = Devagadi, Knight (see Sunnabile and Sonnabile).

Sanno-Gheura.—Nepal, India, Watt's Dict. 6(2):66, = Chitu.

San Pello.—Brazil, = Manteiga, Deerr (see Sem Pello).

San Salvador.— = Striped Cheribon, Deerr.

Santo Domingo.—Cuba, = Cavengirie, Deerr, 58.

Sarangola.—Porto Rico, a local name sometimes applied to Crystalina.

Sarantia.—India, N. W. Prov., Watt's Dict. 6(2):62.

Sararu.—India, Watt's Dict. 6(2):67.

Sarauti.—India, Clark and Hadi.

Sarawati.—India, Bengal (Chapman), Watt's Dict. 6(2):60.

Saretha.—India, a group name, Barber, Studies, 2, 3.

Saroti.—India, Watt's Dict. 6(2):60.

Sarotiyo.—India, Watt's Dict. 6(2):60.

Saska.—Java, from Sumatra, Wakker, 1896.

Sathi 131.—Pusa, India, Dastur, Int. Sug. Jour., Nov., 1923, p. 596, = Mauritius 131 ?

Sawoer.—Java, from Java, Wakker, 1896, = Idjo, Hong-Kong, Kobus, Med. 6, 1893; Soltwedel, Fig. 30, which represents a slender greenish cane with bloom much blackened by sooty mould; constricted at growth ring. It resembles the Chinese canes.

SC.—(Initials with numbers): Brazil, Pernambuco, = Cannas de Sao Caetano, Bull. 3; Virgin Islands, = seedlings grown at the St. Croix Exp. Sta. by Longfield Smith, Rept. 1:14, 1913. (In recent years SC 12(4) has been widely planted in the West Indies); Barbados, Rept. 1916–18:69, probably refers to St. Croix Seedlings. Gorkum, in Brazil, also used the initials SCA, ScB, and SCH but without explanations.

Scard.—Demerara, Harrison and Jenman, West Ind. Bull. 1(4):381, 1900.

Scavangerie.—Guadeloupe, Boname, 1888; Mauritius and Réunion, from New Caledonia, Sagot, 328, = Cavengirie, Deerr.

Schimate.—New Caledonia, Vieillard, 1863, Sagot, 346.

Sealey's Seedling.—Barbados, = Blackman's Seedling, Bovell, West Ind. Bull. 2:26, 1901; Trinidad Bull. 73, 1919; Porto Rico, various publications.

Seche.—Boname, Mauritius, 1895 (see Seete?—)

Securi.—Queensland, from Louisiana, 1895, Easterby (see Sacuri).

Seema.—Louisiana, from British India, Agee.

Seet.—Jamaica, from Mauritius, 1882. D. Morris; Demerara, Harrison and Jenman; = Striped Cheribon, Deerr; Argentina, Fawcett, Int. Sug. Jour., 13:473, 1911 is a white cane.

Selabaloss.—Java, Kobus, Med. 6, 1893.

Selangore.—Jamaica, Demerara (see Salangor).

Selasih.—Java, from Sumatra, Wakker, 1896.

Sem Pello.—Brazil, Sao Paulo, Bull. 16:942, 1915; also Gorkum (see San Pello).

Senkoekoen.—Java, from Borneo, Wakker, 1896.

Sepadeh.—Java, from Sumatra, Wakker, 1896.

Sepang.—Java, from Sumatra, Wakker, 1896.

Serrat.—Queensland, from Java, 1878, Easterby (see Soerat).

Settlers.—Mauritius, Boname, 1896 (by misprint Setters).

Sewari.—Behar, India, belongs to Nagori group; semi-aquatic, Int. Sug. Jour., Oct., 1925, p. 532, Feb., 1925, p. 81.

Shahjahanpur 10.—Queensland, from India, 1915, Easterby, Bull. 2, 1926; Argentina, from Queensland, Cross, Facts About Sugar 8/23–24, p. 185; POJ 36.

Shahjahanpur Black.—Australia, from India, Int. Sug. Jour., May, 1925, p. 243.

Shakarchina.—India, Watt's Dict. 6(2):60; Queensland, from Mauritius, 1902, Maxwell, Easterby (see Shukurchina).

Shakar Chinya.—India, Taylor, Woodhouse, Wayer.

Shakar Chynia.—India, Barber Studies, 2 ?

Shamshara.—India, Taylor, Woodhouse, (see Rood and Geel Shamshara, Java) (see Samsara and Somsarrah), (= Otaheite).

Sharang.—India, Bengal (Chapman), Watt's Dict. 6(2):60.

Shoo.—New Caledonia, Breslan, 1884, Sagot, 331.

Shukurchina.—India, Papers—Sugar, 3d. Ap., 35, 1822 (see Shakarchina, etc.).

Siah.—India, Watt's Dict. 6(2):69.

Siepa.—New Caledonia, Breslau, 1884, Sagot, 333.

Sigei.—Java, from Bovenlanden, Wakker, 1896.

Simi.—India, Int. Sug. Jour., 2:469, 1900.

Simpson.—Georgia, Florida, = Green Ribbon, Yoder, U. S. Dept. Agr. Bull. 486:7, 1917.

Sinanduyong.—Philippines, Mendiola, Identification Key, Sug. News 3(1) Jan., 1922; A. P. Adriano, Phil. Agr. and Forest 3(2):41; J. J. Mirasol, Phil. Agr. and Forest. 4(5):107, 1915.

Singaing Red.—Burma, from India, Facts About Sugar 10/7–22, p. 301.

Singapore.—India, Watt's Dict. 6(2):49 (a mixture of varieties); Java,

from Australia, Wakker, 1896; Demerara, Harrison and Jenman; = Otaheite, Deerr.

Sin Nombre.—(With numbers): Argentina, a series of unknown canes at the Tucuman Exp. Sta. They are from Java and some are very promising, Cross, Int. Sug. Jour., Apr., 1925, p. 202.

Sipadeh.—Java, from Sumatra, Wakker, 1896.

Sirah.—Java, from Sumatra, Wakker, 1896.

Sisieg.—Java, from Sumatra, Wakker, 1896.

Sisie Koening.—Java, from Sumatra, Wakker, 1896.

Sisie Merah.—Java, from Sumatra, Wakker, 1896.

SJQ.—(Initials with numbers): Seedlings produced by Bureau of Sugar Exp. Sta. at Mossman, Queensland, Easterby, Bull. 2, 1926.

Small Ribbon.—Queensland, Davidson, 1880 (= Striped Cheribon).

Small Yellow.—Queensland, Davidson, 1880, Easterby.

Socrat.—Queensland, from Java, 1874, Easterby (a misprint for Soerat).

Soerat.—A Malay word meaning striped, applied to any striped cane; when used alone usually = Striped Cheribon.

Soerat Balie.—Java, from Java, Wakker, 1896; Kobus, Med. 6, 1893.

Soerat Banka.—Java, Kobus, Med. 6, 1893.

Soerat Bantang.—Java, Wakker, 1896; Soltwedel, Fig. 17. A stout, short-jointed cane with light and dark purple stripes; nodes oblique, strongly constricted, rudimentary roots large, in 2 or 3 rows; buds thick, suborbicular but apiculate, resembles Striped Tanna.

Soerat Buding.—Java, from Java, Wakker, 1896.

Soerat Gempolkereh.—Java, Soltwedel, Fig. 22, a medium slender green and brown-red striped cane with heavy bloom; internodes cylindrical, slightly constricted at growth ring; buds small, suborbicular.

Soerat Hongkong.—Java, Oost-Java, Med. 9:19.

Soerat Idjoe.—Java, from Batjan and New Guinea, Wakker, 1896.

Soerat Item.—Java, from Borneo and Fiji, Wakker, 1896.

Soerat Koening.—Java, from Fiji, Wakker, 1896.

Soerat Mangli.—Java, from Java, Wakker, 1896; Soltwedel, Fig. 23, a rather stout, green and red-brown striped cane; nodes conspicuously swollen; buds suborbicular with a conspicuous apical tuft of stiff barbs.

Soerat Mauritius.—Java, Soltwedel, Fig. 24, a medium-slender cane with narrow red and brown stripes; internodes long, somewhat curved, enlarged below; buds rather large, triangular-ovate, a peculiar appearing cane; Mauritius, = Branchu Rayée, Deerr.

Soerat Merah.—Java, from Hawaii, Wakker, 1896.

Soerat Njampl.—Java, from Java, Wakker, 1896.

Soerat Njamplong.—Java, Soltwedel, Fig. 20. A medium-diameter, green and purple or yellow and purple striped cane; internodes cylindrical, or nodes slightly constricted; buds broad, triangular, with shouldered margin. The shape of the buds makes it clearly Striped Cheribon.

Soerat Redjo.—Java, from Java, Wakker, 1896; Geerligs Med. West-Java 27.

Soerat Telok Betong.—Java, Med. Oost-Java, 47:58.

Soerat Tjeribon.—Java, Kobus, Med. 6, 1893 (= Striped Cheribon).

Soethers.—Mauritius, 1824, introduced by a man of that name. On being sent to Java, the name was misread as Loethers, which see; Deerr, 612.

Solangor.—Brazil, = Listrado de Roixa, Moreiro 1876 (see Salangor).

Solera.—Deerr, 52 (see Otaheite).

Somsarrah.—Mauritius, from India, Horne, 1869 (see Samsara).

Sonabochi.—North India, Barnes.

Songada Rati.—Bombay, India, Knight, = Hard Red.

Soniat.—Louisiana, a white bud sport, Stubbs.

Sonnabile.—India, Agr. Inst. Pusa, Bull. 83:33, 1919 (see Sannabile and Sunnabile).

Spaansch.—List canes Arlington Greenhouses (in lit.).

Spotted Mappoo.—Queensland, from Mauritius, Easterby, 1878.

Standard.—Argentina, from Peru, Cross, Facts About Sugar 5/23–25, p. 495.

Sthiabangui.—New Caledonia, Vieillard, 1863, Sagot, 346.

Striped Ambos Camarines.—Philippines, Hines = Striped Leyte.

Striped Bamboo.—Mauritius, = Striped Cheribon, Deerr.

Striped Bansa.—India, Taylor, Woodhouse.

Striped Bourbon.—Queensland, from Singapore, Davidson, 1880, Easterby (= Horne or Green Ribbon).

Striped Cheribon.— = Rayada and Listada of Spanish America, = Diard Rayée, = Home Ribbon, Mauritius Ribbon, Louisiana Striped, Red Ribbon, San Salvador, Seete, Striped Bamboo, Striped Mexican, Striped Preanger, Striped Singapore, Transparent, Deerr. (Most of these go to Striped Preanger according to Jeswiet.)

Striped Egyptian.—Barbados, Rept. 1905–7:23, 1908; **Trinidad**, Bull. 18:74, 1919.

Striped Fiji.—Java, from Australia, Wakker, 1896.

Striped Goru.—Queensland, from New Guinea, **Trion No. 24A, =** Goru Seela Scelana, based on same number.

Striped Iscambine.— = Tsimbic, Deerr.

Striped Isaacs.—N. S. Wales, Colonial Sugar Co. permits planting in certain districts, Int. Sug. Jour., 1:506, 1899.

Striped Java.—Mauritius, Boname, 1898–9 (= Striped Cheribon).

Striped Leyte.—Philippines, = Striped Ambos Camarines, Hines, Rev. 8:153, 1915.

Striped Louisiana.— = Striped Cheribon, Deerr (= Striped Preanger, Jeswiet).

Striped Mappoo.—Queensland, from Mauritius, 1878, Easterby.

Striped Mauritius.—India, Barber, Studies, 2; Sayer, Ind. Sug. Ind. 8, in great favor at Madras, succeeding in Assam, high-purity juices;

Deerr (in lit.), in India = Cavengirie; Deerr, Bombay, India (in lit. 1/1–21, here = Striped Cheribon but much mixed with other striped kinds, not striped Tanna.

Striped Mexican.— = Striped Cheribon, Deerr; Hawaii, Lyon Bull. Bot. 3(1):7, 1921. Very resistant to mosaic, practically immune; Porto Rico, from Mexico, indistinguishable from Rayada = Striped Preanger, and equally attacked by mosaic.

Striped Preanger.— = Striped Cheribon, Deerr; Formosa, Ishida, Sug. Sta. Bull. 1:44, 1921 (now considered distinct from Cheribon by Jeswiet).

Striped Singapore.— = Striped Cheribon, Deerr; Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920.

Striped Soekabumi.—Formosa, Ishida, Sug. Sta. Bull. 1:43, 1920.

Striped Tanna.—Queensland, from Mauritius, 1878, Easterby; Mauritius, from Queensland, 1890, Agr. Dept. Bull. 2:11, 1916; Barbados, Rept, 1917–19; 60: N. S. Wales, Colonial Sugar Co. permits planting, Int. Sug. Jour., 1:506, 1899, = Big Ribbon, Guingham (in part), Maillard, Otaheite Ribbon (Wray), Teboe Soerat (Java), Deerr (citations often confused with Striped Cheribon).

Striped Tip.—Hawaii, Deerr; Lyon, Bull. Bot. 3(1):1 and 10, 1921. A native cane, badly attacked by mosaic. = Daniel Dupont, Moir.

Sucker.—Jamaica, Jour. Agr. Soc. 20:12, 1916.

Sug.—Queensland, from Java, 1878, Easterby.

Sukli.—India, Taylor, Woodhouse.

Suku.—Jamaica, Bull. Bot. Gar. 3(N. S.):206, 1896.

Sumatra.—Argentina, from Brazil, Zerban, 1910.

Sumatra Groen.—Java, Kobus, Med. 6, 1893.

Sumatra Paars.—Java, Kobus, Med. 6, 1893.

Sumatra Poetih.—Java, Kobus, Med. 6, 1893.

Sumatra Rood.—Java, Geerligs, Med. West-Java 27.

Sumatra Wit.—Java, Geerligs, Med. West-Java 27.

Sunnabile.—India, a group name, Barber, Studies, 3 (see Sonnabile and Sannabile).

Surat.—(As used by Kruger = Soerat).

Suretha.—North India, Barnes (see Saretha).

Surri.—India, Watt's Dict. 6(2):70.

Surta.—India, Watt's Dict. 6(2):67.

SW.—(Initials with numbers): Java, = Sempalwadak Seedlings, a series made in 1904 by crossing Batjan as staminate on Zwart Cheribon as pistillate parent, Arch. 17:662, 1909; Jeswiet Med. 3, 1917; Harreveld, Med. 15, 1917.

T.—(Initial with numbers): = Trinidad Seedlings, 1895 to 1904.

Tacuara.—Argentina, Rev. Tuc. 3:339, 1913.

Tadjam Mata.—Java, from Sumatra, Wakker, 1896.

Talahib.—Philippines, = Wild *Saccharum spontaneum,* Otto Reinkin, Sug. News 2:94, 1921.

Talang.—Java, from Sumatra, Wakker, 1896.

Tamarah.—Queensland, from Mauritius, 1878, Easterby.

Tamarin.—Mauritius, from New Caledonia, 1870, Dept. Agr. Bull. 2:11, 1916; Boname, 1895, 1896, probably = Settlers. (The name comes from a locality in Mauritus); Queensland, from Mauritius, 1902, Maxwell, Easterby; Natal, mentioned as a favorite cane, The Sugar Cane 9:322, 1877; Brazil, Sao Paulo Sawyer; Porto Rico, Stahl, 1800, Lopez Tuero, introduced after 1878, Stahl Rev. de Agr., 1877, p. 174; Demerara (as Tamarind), Harrison and Jenman.

Tambada.—Bombay, India, Knight, = Kare Rasdali.

Tambdi.—India, Watt's Dict. 6(2):74.

Tambiada.—Guadeloupe, Boname, 1888, recently imported to Mauritius from New Caledonia.

Tambiapin.—Mauritius, Boname, 1898–9.

Tambiola.—Mauritius, and Réunion, from New Caledonia, Sagot, 328.

Tangalite.—New Caledonia, Vieillard, 1863, Sagot, 346.

Tangerang.—Java, from Java, Wakker, 1896; Kobus, Med. 6, 1893; Van Derventer, Handb. 5:151, 1915; Soltwedel, Fig. 10. A medium-stout, reddish cane; internodes barrel-shaped; nodes constricted; buds ovate.

Tangio.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869.

Tanna.—The Tanna Canes, Deerr; Light Tanna = White Tanna, Green Tanna, Malabar, Yellow Caledonia; Striped Tanna = Big Ribbon, Daniel Dupont (in part), Guingham, = Black Tanna. All are said to resist gum disease. Striped Tanna reached Mauritius in 1870, = Wopendon, Deerr, 612.

Tapara Buria.—Queensland, from Java, 1878, Easterby (see Japara).

Tapoura Poe.—New Caledonia, Breslan, 1884, Sagot, 344.

Teboe.—The Malay name (in Java) for sugar cane. As a prefix it has been disregarded in this list; also written Teboo, Tebu, Tebbou, Tiboo, Teboe, Tibour and Tegboa.

Teelor.—Straits Settlements, Wray = Egg Cane.

Tegal Waroe.—Java, from Java, Wakker, 1896.

Tekcha.—Argentina, from Formosa, Rev. Tuc. 9(1):14, 1918. (One of the Chinese canes, *Saccharum sinense* group.)

Tekucha.—Formosa, Ischida, Sug. Sta. Bull. 1:42, 1920; So. Africa, from Formosa, Choles.

Telfair.—Sagot, 326.

Telor.—Java, from Riouw, Wakker, 1896 (see Teelor).

Tengger.—Java, Oost-Java Med. 9:19; Kobus, Med 6, 1893.

Tereru.—India, Barber, Studies, 1, = Teru.

Tergun.—Java, from Sumatra, Wakker, 1896.

Teru.—North India, Barnes, Barber, Studies 2, 3 (= Tereru).

Tezal Warroe.—Maritius, from Java, Horne, 1869 (see Tegal Warroe).

Thirri.—India, Watt's Dict. 6(2): 70.
Thoon.—Java, from British India, Kobus, Med. 48, 1893.
Thsiogan.—New Caledonia, Vieillard, 1863, Sagot, 347.
Thuri.—India, Watt's Dict. 6(2): 62.
Tiambo.—Bahia, Brazil, The Sugar Cane 22: 483, 1890 (see **Tsiambo**).
Tiboe.—Queensland, from So. Sea Islands, 1874, Easterby (see Teboe).
Tiboo.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869; Jamaica, from Mauritius, 1882, D. Morris (see Teboe).
Ti Bore.—New Caledonia, Breslau, 1884, Sagot, 338.
Ti Botti.—New Caledonia, Breslau, 1884, Sagot, 340.
Ti Brou.—New Caledonia, Breslau, 1884, Sagot, 341.
Ti Brou Opa.—New Caledonia, Breslau, 1884, Sagot, 341.
Ti Ca Semba.—New Caledonia, Breslau, 1884, Sagot, 342.
Ti Chigaka.—New Caledonia, Breslau, 1884, Sagot, 340 (see Chicagaca).
Tigbao.—Philippines, Facts About Sugar, 5/18–25, p. 379.
Ti Grivailho.—New Caledonia, Breslau, 1884, Sagot, 338.
Ti Ka Ti.—New Caledonia, Breslau, 1884, Sagot, 338.
Tikona.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869.
Tilibi.—New Caledonia, Vieillard, 1863, Sagot, 347.
Ti Ma.—New Caledonia, Breslau, 1884, Sagot, 335.
Ti Mahoun.—New Caledonia, Breslau, 1884, Sagot, 336.
Ti Mandou.—New Caledonia, Breslau, 1884, Sagot, 340.
Ti Manguendon.—New Caledonia, Breslau, 1884, Sagot, 335.
Timboe.—New Caledonia, Breslau, 1884, Sagot, 336.
Ti M'n're.—New Caledonia, Breslau, 1884, Sagot, 338.
Timor.—Java, Oost-Java Med. 26: 3; Kobus, Med. 6, 1893; Van Derventer, Handb. 5: 151, 1915.
Ti O.—New Caledonia, Breslau, 1884, Sagot, 337.
Ti One Pa.—New Caledonia, Breslau, 1884, Sagot, 341.
Ti Ooeti.—New Caledonia, Breslau, 1884, Sagot, 340.
Ti Oue.—New Caledonia, Breslau, 1884, Sagot, 343.
Ti Ouegna.—New Caledonia, Breslau, 1884, Sagot, 338.
Ti Ouependon.—New Caledonia, Breslau, 1884, Sagot, 343.
Tip Canes.—Hawaii, Deerr, grown at high altitudes, Striped Tip and the variants Yellow Tip and Red Tip. Closely resemble Branchu Rayée and Branchu Blanche of Mauritius (= Daniel Dupont, Moir).
Ti Poriman.—New Caledonia, Breslau, 1884, Sagot, 343.
Ti Quiman.—New Caledonia, Breslau, 1884, Sagot, 337.
Ti Rrré.—New Caledonia, Breslau, 1884, Sagot, 342.
Tischiepa.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869.
Tita.—Brazil, = Imperial, Weller, The Sugar Cane 25: 187, 1893.
Ti Tentankoe.—New Caledonia, Breslau, 1884, Sagot, 336.
Ti Tie.—New Caledonia, Breslau, 1884, Sagot, 334.
Ti Tohou.—New Caledonia, Breslau, 1884, Sagot, 334.
Ti Tonghoi.—New Caledonia, Breslau, 1884, Sagot, 340.

Ti Tshani.—New Caledonia, Breslau, 1884, Sagot, 338.

Tjemang.—Java, from Bali, Wakker, 1896.

Tjepering.—(With numbers): Java, Med. 7:813, 1917. Tjepering 24 is a thick cane said to be immune to mosaic.

Tjeribon.—Java, Kobus, Med. 6, 1893 (see Cheribon).

Tjeribon Koening.—Java, Kobus, Med. 6, 1893.

Tjibaran.—Java, from Sumatra, Wakker, 1896.

Tjina.—Java, from Sumatra, Wakker, 1896.

Tjipoet.—Java, from Sumatra, Wakker, 1896.

Tjoerieng.—Java, from Bovenlanden, Wakker, 1896.

Tjoreng.—Java, from Sumatra, Wakker, 1896.

Tkouo.—Queensland, from So. Sea Islands, Easterby

To Aeho.—Society Islands, Cruzent, 1860.

To Avae.—Pacific Islands, Deerr; = Cane Jaune de Tahiti, Sagot, 334, 1893 (Otaheite).

Toeboe Marafoli.—Borneo, Rumphius.

Toengkei.—Java, from Sumatra, Wakker, 1896.

Toetoeng.—Java, from Sumatra, Wakker, 1896.

To Irimotu.—Sagot, = Canne Crosse Verte de Tahiti.

Toledo.—Philippines, found by Dr. Brandes on the plantation of Sr. Roberto Toledo, Tampanga, immune to mosaic, Facts About Sugar, 4/21–23, p. 314.

Tombiamie.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869.

Tombiapa.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869.

To Oura.—Pacific Islands, Deerr.

To Patu.—Society Islands, Cruzent, 1860.

Tora.—India, Watt's Dict. 6(2):70.

To Rurutu.—Sagot, 329, 1893, = To Rutu = Canne de Rurutu.

To Rutu.—Sagot, 329, 1893, = To Rurutu.

Toungoo.—Burma, = Otaheite. This stock can be traced to Mauritius in 1827 and so must be of the original strain imported by Bonginville in 1767, Deerr (in lit. 3/25–21).

Toungoo Yellow.—Deerr, 613, = Otaheite, Burma; mentioned Rept. Indian Sug. Com., Int. Sug. Jour., Sept., 1921, p. 559.

To Uouo.—Sagot, 324, 1893, = To Vaihi = Canne Blanche de Tahiti; Australia = Ribbon, Melmouth Hall.

Tourkoury.—Jamaica, from Mauritius, 1882, D. Morris.

To Ute.—Tahiti, Bennett, the Sugar Cane 5:693, 1874; Cruzent, Simmons Trop. Agr. 1877, Queensland, from Society Islands, Davidson, Easterby; Pasific Islands = *Saccharum Alborubens*, Deerr (= Djamprik).

To Vaihi.—Sagot, 324, 1893, = To Uono = Canne Blanche de Tahiti.

Tranchada.—Pernambuco, Brazil, Bull. 3.

Transparent.— = Ribbon = Striped Cheribon, Deerr (see Canne Transparent).

Transparent Ribbon.—Queensland, from Batavia, prior to 1878, Easterby, Bull. 2, 1926 (= Striped Cheribon).

Treda.—India, Watt's Dict. 6(2): 66.

Treru.—India, Watt's Dict. 6(2): 67.

Trimotu.—Queensland, = Salangor, Easterby.

Trinidad.—Mauritius, Horne, 1869; Boname, 1896, 1898–9.

Troeboe.—Java, from Java, Wakker, 1896; Kobus, Med. 6, 1893; Soltwedel, Fig. 28, a slender, dark green cane with swollen nodes, characterized by a retained abortive inflorescence that is eaten like cauliflower, = *Saccharum edule.* Hassk; Queensland, from New Caledonia, 1870, J. Hill; Davidson, 1880, Easterby. Queensland descriptions call for a dark-colored cane, evidently distinct from that of Java.

Trunotu.—Queensland, from Society Islands, 1878, Easterby.

Tschiemie.—Queensland, Easterby.

T' Shiambe.—New Caledonia, Breslan, 1884, Sagot, 344.

Tsimbic.—Jamaica, from Mauritius, 1882, D. Morris; Louisiana, from Jamaica, Stubbs, Agee, = Striped Iscambine, Deerr.

Tsimbo.—Mauritius and Réunion, from New Caledonia, Sagot, 328; Guadeloupe, Boname, 1888; Argentina, = Fiamo (see Tiambo and Fiambo).

Tubu.—A native name for sugar cane, Rumphius.

Tumbia Mie.—New Caledonia, Breslau, 1884, Sagot, 334.

Tumbia Sa.—New Caledonia, Breslau, 1884, Sagot, 334.

Tunia.—India, Watt's Dict. 6(2): 69.

Uba.—Brazil, Moreiro, 1876 (on page 6, Uba is mentioned under date of 1859); Mauritus, from Brazil, Horne, 1869; So. Africa, Choles, Dept. Agr. Jour., 5, 1913, has superseded all other canes; Argentina, from Natal, Rev. Tuc. 8(1): 14, 1918; Rev. Tuc. 9(9 and W.): 144, 1919, Fawcett, = Kavangire; Queensland, = Yuba and Yuban, Easterby; Louisiana, Diamond = Zwinga (an error, Uba is distinct from Zwinga); Jamaica, from Zululand, on recommendation of Lord Kitchner, Ann. Rept., 1917; Barber, Int. Sug. Jour., Jan., 1918, places Uba among the Ganna canes of India. (Later he places it in the Pansahi group.) It is the best known of the Chinese canes, *Saccharum sinense* group. Fawcett and Cross were in error in considering it the same as Kavangire. As grown side by side in Cuba, they are clearly distinguishable. The varieties in this group, while distinct, run very close together and are hard to distinguish by diagnostic characters

Uga.—A native name for sugar cane, Rumphius.

Ukh.—India, a class name used by Hadi for thin, reed-like canes, Deerr.

Ula.—Java, from Malacca, Wakker, 1896.

Umoba.—So. Africa, Choles, a native Zulu name, = green.

Uouo.—Pacific Islands, = Vaihi, Deerr (see To Ouou).

Utan.—Java, from Malacca, Wakker, 1896.

Uwala.—Louisiana, from Hawaii, Stubbs, Agee.

Vagabonde.—Demerara, Harrison and Jenman; Java, from Malacca, Wakker, 1896.

Vaihi.—Society Islands, Cruzent, 1860; Otaheite, Bennett, 1874, = Uouo, Deerr (see To Vaihi).

Vambox.—Queensland, from Singapore, 1880, Easterby.

Vansaigari.—Bombay, India, Watt's Dict. 6(2):73.

Vansi.—Bombay, India, Watt's Dict. 6(2):73.

Vara.—Bombay (Ozanne), a class name, Watt's Dict. 6(2):74.

VD.—(Initials with numbers): Java, Ledeboer, Med. 4:452, 1917.

Veico.—Fiji, Lyon, Hawaii Bot. Bull. 3(1):34, 1921, a wild reed-like cane, the native host of Fiji disease.

Vellai.—India, Barber, Studies, 2.

Vendamukhi.—Bengal, India, Pusa Bull. 83:27, 1919.

Venezuelan Bourbon.—Trinidad, Williams, Bull. 18:74, 1919, a reddish green cane.

Verde das Antillas.—Argentine, from Brazil, Zerban, 1910.

Verde de Jujuy.—Argentina, Rev. Tuc. 9:133, 1919, Fawcett, description and figure, = Otaheite, Deerr, 52.

Verde Gruesa.—Argentina, from Brazil, Zerban, 1910.

Verde Zic-Zac.—Porto Rico, Stahl, 1880 (possibly the zig-zag green cane figured by Tussac which Deerr reports having seen in Porto Rico).

Vermehla.—Brazil, = Bois Rouge, Deerr; Brazil, from Mauritius, 1857, = Roxeada, Deerr, 49.

Verte Jardin.—Mauritius, Boname, 1898–9.

Verte Pays.—Mauritius, Boname, 1895, 1898–9.

Veu.—Tahiti, Bennett, The Sugar Cane, 6:593, 1874.

Vico.—Demerara, Harrison and Jenman; Java, from Malacca, Wakker, 1896.

Vilaine.—Mauritius, Boname, 1898–9.

Vinagre de Sao Samao.—Argentina, from Brazil, Zerban, 1910, = Tebu, Djamprik, leaves purple, also seen in Peru.

Violacea.—Brazil, Moreira, 1876, = Roixa.

Violet.—Sillman, Manuel, 1833, cites Tussac and Humboldt and Bonpland; Australia, Melmouth Hall, The Sugar Cane, 6:588, 1874, "abounding in cane itch"; Jamaica, MacFadyen, 1830, = Batavian cane, Black cane, Claret cane, Imperial and Mount Blank. (It includes Black Cheribon and others.)

Violeta de San Augustin.—Argentina, Cross, Facts About Sugar 5/23–25, p. 495, from Peru.

Violet Ribbon.—Australia, = Tabor Soerat of Java (Diard), Angus Mackay; Demerara, Harrison and Jenman (= Striped Cheribon).

Violet Salangore.—Trinidad, provisional name proposed by Mr. Purdie, The Sugar Cane 11:585, 1879.

Violet Tita.—Brazil, Weller, The Sugar Cane 25:187, 1893.

Vitua-haula.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Har-

rison and Jenman; Louisiana, from Jamaica, Stubbs; Java, from Malacca, Wakker, 1896, = Louzier, Moquette, Arch. 6:292, 1898.

Vopa.—New Caledonia, Breslan, 1884, Sagot, 333.

Vulu Vulu.—Jamaica, from Mauritius, 1882, D. Morris; Demerara, Harrison and Jenman; Louisiana, from Jamaica, Stubbs, Agee; Java, from Malacca, Wakker, 1896.

W.—(Initial with numbers): Barbados, Rept. 1905–7:33; Antigua, Watt's; Lee-ward Islands, 1916–17. (See Walton's Seedlings, also Watterford).

Wagaisy.—Mauritius, from New Caledonia, (Lavignac) Horne, 1869.

Walton's Seedlings.—Barbados, Rept. 1912–14:54, 1914 (see W).

Wanga Aloes.—Java, Kobus, Med. 6, 1893.

Wanga Gros.—Java, Kobus, Med. 6, 1893.

Wanga Warottan.—Java, Kobus, Med. 6, 1893.

Wansia.—Bombay, India, Knight, = Khadya.

Waphendnow.—Jamaica, from Mauritius, 1882, D. Morris.

Watterford.—(With numbers): Barbados, Rept. 1909–11; 23 (see W, also Walton's Seedlings).

Weri.—Java, Kobus, Med. 6, 1893.

West Indian Creole.—Demerara, Harrison and Jenman, = Barbados Native (Creole).

Whitcaloran.—Philippines, from Australia, Hines, Agr. Rev. 8:158, 1915.

White Aboe.—Mauritius, Horne, 1869, = White Rappoe.

White Bamboo.—Queensland, from Mauritius, 1877, Maxwell, Easterby; Louisiana, from Jamaica, Agee; Hawaii, Lyon (in lit. 3/22–23), a good commercial cane said to be immune to mosaic. (The name is applied to a number of different canes in different countries.)

White Bombay.—India, Watt's Dict. 6(2):60.

White Cane.—Java, Kajenbrink, 1879 = Teboe Pring.

White Cheribon.— = Light Cheribon, Deerr.

White Creole.—Jamaica, West Ind. Bull. 6:339, 1906.

White Elephant.—Jamaica, Bull. 4:227, 1897, = Caledonian Queen, Java, Hope (= Crystalina).

White Japanese Cane.—Philippines, Mendiola, Identification Key, Sug. News, 3(1), Jan., 1922.

White Luzon.—Philippines, Hines, Agr. Rev. 8:153, 1915 (see Luzon White).

White Manila.—Java, Deerr (see Luzon White).

White Mauritius.—India, Barber, Mem. Dept. Agr. 7:25, 1915 (= Crystalina ?); Woodhouse, = Otaheite; Demerara, = Salangor, Harrison and Jenman.

White Mexican.—Queensland, from Honolulu, 1906, Easterby; Louisiana, Agee, = Otaheite, Deerr, 52.

White Native.—Negros, Philippines, Walker (see Luzon White).

White Queen.—So. Africa, Choles.

White Rappoe.—Mauritius, = White Aboe, Horne, 1869.

White Sport.—Barbados, Rept. 1905–7: 34.

White Striped Bourbon.— = Green Ribbon, Deerr.

White Surati.—Bombay, India, Knight, = Khajuria, = Mewa.

White Tanna.—Mauritius, a sport from Striped Tanna at Pamplemousse, also introduced as Green Tanna from N. S. Wales, 1895, Dept. Agr. Bull. 2, 1916, = Yellow Caledonia, = Malabar, Deerr.

White Transparent.—Jamaica, = Mont Blanc, = the Otaheite introduced by Capt. Bligh, West Ind. Bull. 8: 26, 1907; Demerara, = Caledonian Queen, Mamuri, Rappoe, Hope, Light Java, Cheribon, Blue Cane, Crystalina, Rose Bamboo, Light Purple, Harrison and Jenman; = Crystalina, Deerr.

Wieke.—(With numbers): Queensland, from Mauritius, 1901, Easterby.

Wit.—**Java,** = Bamboo, Pring, Rotan, Pontih, Sagot, 326.

Wit Carp.—(With numbers): Java, Harreveld, Med. 15, 1917.

Wit Ceram.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911.

Wit Manila.—Java, Wilbrink and Ledeboer, Med. 6: 86, 1911 (see Luzon White); Harreveld, Med. 15, 1917; Van Derventer, Handb. 5: 148; Jeswiet, full description, Med. Deel? 6(13): 392, 1916.

Wit Mappoe.—Java, Geerligs, Med. West-Java 27.

Woelong.—Java, from Java, = Assch., Wakker, 1896; Gonsalves, = Black Cane.

Woengoe.—Java, Kobus, Med. 6, 1893.

Woengoe Soerat.—Java, from Java, Wakker, 1896.

Wolmer.—(With numbers): Queensland, from Mauritius, 1901, Easterby.

Wopendon.— = Striped Tanna, Deerr, 612, the native name under which it was imported to Mauritius in 1870.

Yasquia.—Jamaica, from Mauritius, 1882, D. Morris (see Ysaquia).

Yellow.—Louisiana, = Otaheite, Stubbs.

Yellow and Green.—Mauritius, from West Indies, Horne, 1869.

Yellow and Red Striped.—Bahia, Brazil, The Sugar Cane, 22: 483, 1890.

Yellow Bamboo.—Hawaii, Eckert, Bull. 7, 1905; Deerr and Eckert, Bull. 26: 19, 1908; Lyon, Bull. Bot. 3(1): 10, 1921, a native cane.

Yellow Bourbon.—Evans, The Sugar Planters' Manual 37, 1847, "Often confounded with Yellow Otaheite."

Yellow Caledonia.—Louisiana, from Hawaii, Stubbs, Agee; Hawaii, = White Tanna, Green Tanna, White Bamboo, and Malabar, Deerr and Eckert, Bull. 26: 14, 1908.

Yellow Cane.—Queensland, Mackay, The Sugar Cane, 7: 187, 1875.

Yellow Egyptian.—Barbados, Rept. 1905–7: 23, 1908 (= Creole, Jeswiet).

Yellow Java.—Went, West Ind. Bull. 12(4?): 556, 1912, probably = Bourbon.

Yellow Mauritius.—Queensland, from Singapore, 1880, Davidson, 1878, Easterby (= Otaheite).

Yellow Nepaul.—Wray.

Yellow Otaheite.—Evans, The Sugar Planters' Manual 37, 1847, "Often confounded with Yellow Bourbon"; Hawaii, Deerr and Eckert, Bull. 26:24, 1908, = Otaheite.

Yellow Singapore.— = Crystalina, Deerr.

Yellow Tahitian.—Australia, Melmouth Hall, The Sugar Cane, 6:588, 1874, the first cane cultivated in Australia from Tahiti, 1817, by Th. Scott, totally distinct from Otaheite of West Indies, probably = Irmotu.

Yellow Tip.—Hawaii, Deerr (a bud sport of Striped Tip).

Yellow Violet.—Jamaica, Wray (= Crystalina).

Yerra.—Madras, India, Int. Sug. Jour., 2:469, 1900.

Yon Tan San.—Argentina, from Formosa, Rev. Tuc. 9(1):14, 1918, and 9:147, 1919. Immune to mosaic, Fawcett, El Mundo Azucareso, Feb., 1920, p. 206. Saccharum sinense group.

Ysaquia.—Louisiana, from Jamaica, Stubbs, Agee (see Yasquia).

Yuba.—India, Barber, Studies 1, 2; Queensland, = Uba, Easterby.

Yuban.—Queensland, from So. Africa, = Uba, Maxwell, Easterby.

Yumbi.—New Caledonia, Breslan, 1884, Sagot, 331.

Yunscao.—Argentina, from Brazil, Zerban, 1910.

Zambales.—Philippines; J. J. Mirasol, Phil. Agri. and Forest, 4:101, 1915; Mendiola, Identification Key, Sug. News 3(1), 1922; F. J. Gamboa (in lit. 8/26-25) with description, grown extensively near Manila for eating.

Zebu.—Pampanga, Neson (= Pampanga Red).

Zepara.—Mauritius, from Java, Horne, 1869 (see Japara).

Zepara Bina.—Mauritius, from Java, Horne, 1869.

Zig-zag.—Pernambuco, Brazil, a local seedling from Cayania Seed (Otaheite), Int. Sug. Jour., 1:378, 1899.

Zwart Borneo.—Java, Harreveld, Med. 3:1032, 1919 (see Black Borneo).

Zwart Cheribon.—Java, Wilbrink and Ledeboer, Med. 6:86, 1911 (= Dark Cheribon).

Zwart Manila.—Java, from Manila, Wakker, 1896; Wilbrink and Ledeboer, Med. 6:86, 1911; Van Derventer, Handb. 5:149, 1915, dark red leaf sheath with brown bristles (= Negros Purple).

Zwart Muntock.—Java, Kobus, Med. 6, 1893; Van Derventer, Handb. 5:149, 1915; Harreveld, Med. 12, 1708, 1918 (see Muntock).

Zwinga.—Louisiana, from Japan, 1877, identical with No. 24, from Brazil or Uba (a mistake; very close to Uba but distinct) John Diamond; Argentina, from Louisiana, Rev. Tuc. 6(12):516, 1916; Rev. Tuc. 9:146, 1919 Fawcett. This is the so-called Japanese Fodder Cane, widely planted for forage in the southern United States. It is much like Uba but matures later and has less sugar. The "Uba" in Hawaii came from Louisiana and so is probably Zwinga.

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The foregoing list includes eighteen hundred and sixty-seven entries. This is one hundred and seventy-two more than appeared in the first edition of the list. So considerable an increase shows that the field is by no means exhausted. A little has been added to our knowledge of synonyms. We do not know in the least how many of these names represent distinct kinds that are still in existence, how many of them are synonyms, or how many are merely historical memories of kinds that have been completely lost. A list of varieties actually existing in different cane collections in all parts of the world would be exceedingly useful. We cannot know too much about such of these old kinds as still exist, for they necessarily form the foundation stock for all future breeding of new kinds.

APPENDIX II

THE SUGAR-CANE INDUSTRY IN THE MORE IMPORTANT PRODUCING COUNTRIES

This volume would be incomplete without a brief statement of the status of the cane-sugar industry in the important producing countries. An account, arranged in the alphabetical order of the countries, follows.

THE CANE-SUGAR INDUSTRY IN ARGENTINA[1]

This industry is largely centered in the State of Tucuman which lies some 800 miles northwest of Buenos Aires between 26° and 28° south latitude. The cane fields are at an altitude of 1000 to 1600 feet, and this, combined with the latitude, gives a decidedly subtropical climate with frequent touches of frost and occasional hard freezes, but with very hot summers. The cold is about equal to that found in the Louisiana sugar districts, but the summers are hotter and there is less average rainfall, usually about 40 inches.

A sugar experiment station was established by the Provincial Government in 1907, but active work did not begin until 1910. This station has been very active and its work has exerted a profound influence on the industry. All of its directors and most of its technical personnel have been recruited from the Louisiana Sugar Station, so that naturally Louisiana traditions and influence have been strong. Methods of planting and cultivation are largely based on those of Louisiana. Possibly, in view of the drier climate, some of the Cuban methods would be preferable.

Formerly the industry was entirely based on the Louisiana Purple and Ribbon Canes (Dark and Striped Preanger). These are still known as the "Creole" or "Native" canes. As early as 1890 it was noted that yields of these canes were diminishing. Their gradual failure finally led to the establishment of the Tucuman Station and ultimately to their complete replacement by the Java canes, POJ36 and POJ213. This change was completed in 1919. It was not until about this time that it was recognized that the failure of the old varieties was due to an outbreak of mosaic disease to which these Java canes are so conspicuously tolerant.

The full effect on sugar yields of this mosaic epidemic and of the change in varieties by which it was controlled is clearly shown by the following table.

[1] The facts for this brief résumé are largely taken from Rosenfeld's account of the work of the Tucuman Station, published in *Facts About Sugar* during February, 1927, and republished by the Tropical Plant Research Foundation as Scientific Contribution No. 7.

Year	Cane Ground Metric Tons	Sugar Produced Metric Tons
1915	1,797,361	103,979
1916	883,436	44,527
1917	686,540	44,465
1918	1,650,226	86,878
1919	3,225,400	247,535
1924	2,567,713	176,267
1925	4,489,600	309,906
1926	.....	395,733
1927	.....	421,384

Since the domestic consumption is less than 250,000 tons per year, these last crops leave a considerable exportable surplus. A heavy import duty assures the local market to the domestic industry.

THE CANE-SUGAR INDUSTRY IN AUSTRALIA

This is mostly confined to the Province of Queensland, though it includes a small area in New South Wales. It is scattered over a narrow coastal zone, a thousand miles long, extending from 16° to 30° south latitude. The conditions are to a considerable extent artificial, since prices and labor conditions are strictly under government control. Foreign sugar is excluded by an embargo which has recently been extended for an additional three years. Only white labor is employed, and wages are higher than in most other cane-growing countries.

Agricultural practices are somewhat varied but apparently they are usually not unlike those of the red lands in Cuba, except that much fewer ratoon crops are taken.

The industry is unfortunate in the number of really serious cane diseases. Mosaic, gum disease, leaf scald, and Fiji disease are all present. Various root grubs and the weevil stalk borer are also troublesome.

Badila is still one of the principal varieties but a number of local seedlings are coming to be more and more planted. D 1135 shows more resistance to root grubs and borers than the Badila.

Total production has been as follows:

Year	Tons	Year	Tons
1917–18	324,260	1922–23	306,678
1918–19	200,853	1923–24	281,859
1919–20	162,298	1924–25	435,680
1920–21	167,401	1925–26	522,344
1921–22	299,465	1926–27	415,611

Estimates for the 1927–28 crop are for about 450,000 tons. Since the total consumption is only about 330,000 tons these later years show an

export surplus which is mostly marketed in Canada, the United Kingdom, and New Zealand.

THE CANE-SUGAR INDUSTRY IN BRAZIL

Brazil has a very considerable sugar industry but it is widely scattered, some of the principal districts being about Bahia, Pernambuco, and Sao Paulo.

There are some modern mills, but a considerable part of the sugar is still made in small, local, "open kettle" plants such as were in general use a hundred years ago. The better mills mostly make plantation white for local consumption. Only a small part of the output is exported. Local prices are fixed by a Government valorization scheme and are usually about 4½ cents per pound.

Sugar yields are low, usually only from 8 to 9 per cent. This is largely due to the fact that Cavengirie is the kind generally planted. Other kinds are being more and more planted but usually under local names that are not recognizable. Recently the slender POJ canes have been considerably extended.

Mosaic is widespread and is causing serious injuries. Gum disease has been prevalent for many years.

Total annual production figures [2] are as follows:

Year	Tons	Year	Tons
1917–18	251,848	1922–23	761,354
1918–19	183,079	1923–24	799,931
1919–20	455,522	1924–25	812,493
1920–21	340,063	1925–26	650,000
1921–22	491,933	1926–27	700,000

BRITISH GUIANA

See Demerara.

THE CANE-SUGAR INDUSTRY IN THE BRITISH WEST INDIES

Sugar has long been the principal product of the British West Indies. Extensive and long-established industries exist on Barbados, Jamaica, and Trinidad, and on the smaller islands of Antigua and St. Kitts.

There are some modern mills but the manufacturing side has been less progressive than in some of the other producing countries.

Agricultural practices are in many respects very good but there is still a tendency to depend too much on expensive hand labor.

[2] These and most of the other production figures given are from the Reference Book of the Sugar Industry of the World, Vol. VI.

In the question of cane varieties these islands have long been very progressive, Barbados in particular sharing with Java the honor of being first in the propagation of new varieties. Formerly white Transparent (Light Preanger) was universally planted, but it has long been superseded by new, locally produced seedlings. BH 10(12) is probably now more planted than any other kind, but its supremacy is sharply challenged by Ba 11569 and other still newer kinds.

Mosaic disease has occurred widely, but for the most part it is being held in check by eradication methods without forcing a change of varieties. In some districts, however, the immune Uba is being considerably planted.

Average production in tons has been as follows:

	1926–7	1925–6	1924–5	1923–4	1922–3	1921–2
Trinidad	70,000	73,561	69,628	52,045	41,619	59,948
Barbados	75,000	47,535	49,315	44,109	52,715	36,742
Jamaica	65,280	57,675	42,843	34,334	39,049	42,167
Antigua	18,000	12,000	17,300	7,860	12,642	9,850
St. Kitts	14,000	16,380	15,563	10,196	10,735	8,426

THE CANE-SUGAR INDUSTRY IN CUBA

Cuba has the distinction of producing more cane sugar than any other country. It must be admitted, however, that this preeminence is due to extensive plantings rather than to intensive yields, for the average per acre production is far outdistanced, notably in Hawaii and Java. There is some exceedingly good cane agriculture in Cuba. At the present moment she is probably leading the world in the adoption and adaptation of mechanical means of cultivation. It must be admitted, however, that average methods are crude and inefficient and this is reflected in low average acre yields. Most unfortunately, interest in these improved methods has been greatly curtailed by governmental crop restrictions induced by a most unfortunate overplanting of new lands. This overplanting seems to have followed financial readjustments caused by price upheavals after the War, which threw the control of many of the larger properties into the hands of a group of international banking interests.

Bankers are supposed to be conservative and to clamp down the lid sharply when there are signs of overspeculation. In this case, however, it must be admitted that it was the big, American, bank-controlled companies that led in this merry dance of overplanting. One of them alone, in the Province of Carmguay, planted over 50,000 acres of new timber land in the spring of 1924. No one seemed to consider the possibility of world overproduction. All of the others were following suit and planting up to the limit of their resources. At the same time the beet sugar industry of Europe was again getting into full production after its dislocation by the World War. The natural result was the saturation of the world's sugar

markets and a sharp fall in prices. Even so, it is doubtful if the price of sugar would have fallen below the cost of production on really well-managed Cuban properties. It did undoubtedly go below production costs on over-captialized and badly managed places. Its worst effect was, however, to induce the well-meaning but unfortunate attempt of the Cuban Government to stabilize prices by restricting production. This may or may not have saved money for some of the centrals. Its real effect on the market can never be known. Unquestionably, however, it has worked a grave hardship and injustice to the cane grower who in many cases has seen nearly half of his crop left standing in the fields, and to the seasonal workers in both field and factory whose few months of employment were so sharply curtailed.

The most serious effect of these crop restriction decrees is, however, that they have blinded the industry of the nation to the real crisis with which it is confronted. The low price of sugar has but little to do with this crisis. Prices rise and fall according to the inexorable law of supply and demand. Artificial attempts to regulate them always fail. A large part of the sugar crop of Cuba has always been made from cane grown on new timber lands. Most of the mills no longer have great areas of new lands to which to turn as their present fields go out of production. They are faced with the necessity of growing a cane supply on old plowed lands. The methods are absolutely different and are for the most part poorly understood. This forced change in methods of cane growing constitutes the real crisis. Cuba needs higher cane yields with the consequent lower cost of production, rather than higher prices for sugar. She needs better tillage, especially of the ratoon fields, a more intelligent selection of varieties, and, above all, efficient control measures for the mosaic disease that is so rapidly overrunning her fields. Most unfortunately, interest in these vitally important matters has been abruptly halted by these crop restrictions. Planters naturally say, "What is the use of doing all these new things to increase production when we are not permitted to grind what cane we already have?"

Crystalina has long been the only variety in cultivation. This is rapidly changing, and the adaptation of varieties to meet differing conditions is being widely studied. At the moment BH 10(12), Se 12(4) and the stout, newer, mosaic-resistant POJ varieties are receiving most attention. The immune Uba is only being planted extensively at a few places.

Mosaic is still the only one of the major sugar cane diseases present. This is widespread and rapidly increasing. A very few plantations are taking adequate measures to control it, these, as usual, with very gratifying success. For the most part, nature is being allowed to take her course. The inevitable result will be a sharp falling off in production followed in course of time by a radical reorganization of the industry on a sounder agricultural basis. This is what always follows a serious mosaic epidemic. The remedy is unpleasant and very expensive, but nothing short of a real calamity serves to convince cane planters that mosaic is a serious enemy.

The total production for the past ten crops follows:

Year	Tons	Year	Tons
1917–18	3,446,083	1922–23	3,602,910
1918–19	3,971,776	1923–24	4,066,642
1919–20	3,730,077	1924–25	5,125,970
1920–21	3,936,040	1925–26	4,884,658
1921–22	3,996,387	1926–27	4,500,000

The 1927–28 crop is restricted to 4,000,000 tons.

THE CANE-SUGAR INDUSTRY IN DEMERARA

This industry is unique in several important respects. It is located near the sea on marsh lands that have to be protected by dikes, and cultivation is made possible only by an elaborate system of drainage ditches. In some cases these are cleared naturally by gravity at low tide; in others they must be emptied by pumps. The cane is transported to the factory by canals in barges.

Most of the field work has been done by hand labor, but recently attempts at implement cultivation have been made.

Varieties have long received careful attention, Demerara being one of the early centers for the production of new varieties, some of which have been widely planted in other countries. For some years past, D625 has been the principal commercial kind.

Production figures are as follows:

Year	Tons	Year	Tons
1917–18	108,181	1922–23	101,128
1918–19	107,560	1923–24	95,494
1919–20	86,971	1924–25	90,874
1920–21	87,186	1925–26	107,580
1921–22	110,985	1926–27	95,000

THE CANE-SUGAR INDUSTRY IN EGYPT[3]

This industry is confined to the immediate banks of the Nile, along which it extends for a great distance. There are five factories, all belonging to the same interests. Most of the cane is grown by small farmers, by what in Cuba is called the colono system. The climate is subtropical, hence there is a short growing season. This and the presence of mosaic have forced the planting of the POJ canes. POJ 105 is the one most planted. The sugar is all consumed locally.

Production figures are as follows:

[3] Largely drawn from Francis Maxwell's recent book, Economic Aspects of Cane Sugar Production.

Year	Tons	Year	Tons
1917–18	79,488	1922–23	94,554
1918–19	75,899	1923–24	88,382
1919–20	86,712	1924–25	79,918
1920–21	79,706	1925–26	94,286
1921–22	108,963	1926–27	90,000

THE SUGAR-CANE INDUSTRY OF FIJI

A considerable and well-developed industry exists on this far-away island. Agricultural practices seem to be unusually good. They usually include the plowing under of two leguminous cover crops (black velvet beans) after abandoning a field and before replanting. The presence of mosaic, leaf-scald, and Fiji disease makes long ratooning difficult, and the usual practice is to take only one ratoon crop. Badila is planted on from 80 to 90 per cent of the area, the balance being local seedlings and a small but increasing percentage of H 109. This is thought to be more susceptible to Fiji disease than Badila, but it is quite resistant to leafscald and is injured less than Badila by the weevil borer, which is the worst insect pest.

Annual production has been as follows:

Year	Tons	Year	Tons
1917–18	63,009	1922–23	35,544
1918–19	64,348	1923–24	63,898
1919–20	72,985	1924–25	100,810
1920–21	72,624	1925–26	70,567
1921–22	71,731	1926–27	85,000

THE CANE-SUGAR INDUSTRY OF FORMOSA

The chief center of the sugar industry of Japan is in the island of Formosa. This is a high, mountainous, volcanic island, and naturally the sugar-cane districts are in the nearly level basal plane.

The land is trenched by hand into 15- to 30-foot banks to secure drainage. Hand labor seems to be mostly employed in the cultivation. From two to four ratoon crops are usually taken. Until the last few years Rose Bamboo (Light Preanger) and Lahaina (Otaheite) were the kinds chiefly planted. Now fully 80 per cent of the area is in the different POJ hybrids from Java.

Production seems to be steadily increasing:

Year	Tons	Year	Tons
1917–18	397,618	1922–23	405,800
1018–19	415,678	1923–24	448,736
1919–20	283,482	1924–25	554,473
1920–21	342,176	1925–26	616,584
1921–22	406,966	1926–27	504,000

THE CANE-SUGAR INDUSTRY IN HAWAII

These few small islands in the middle of the Pacific support the fourth largest cane-sugar industry in the world, being surpassed only in total production by Cuba, India, and Java. They are unique, however, in efficiency of organization and high mill extraction, and preeminently so in the high yields of cane and of sugar per acre. The 127,417 acres harvested in 1926–7 are said to have made an average sugar yield of 6.377 short tons. Slightly over half of this area was irrigated, and this gave an averge of 8.457 short tons. Central Ewa still holds the world's record with 141.13 tons cane and 18.09 tons sugar per acre on a 120-acre field. The average yield for the entire plantation, crop of 1925 was 11.87 tons of sugar. These very high yields are all from the variety H 109 under irrigation, and from crops eighteen to twenty months old, representing nearly two years of growth.

Very large sums have been spent in developing irrigation. Water is pumped from greater depths and flumed from greater distances than in any other cane-growing country. Such enormous expenditures are justified by the heavy yields obtained and by the fact that the sugar is produced inside of the United States high protection-tariff wall.

The industry maintains one of the best equipped and most efficient experiment stations in the world. Among its many outstanding achievements may be mentioned the successful control of insect pests by introduced parasites and the breeding of the seedling variety H 109 which holds the world's record for highest sugar production.

Agricultural practices are noteworthy for the very thorough preparation of the soil before planting and for good implement tillage in the non-irrigated districts. The texture of the soil is so good in the irrigated lands that record yields are obtained with a minimum of tillage. Fertilizers are extensively used. Only one or two ratoon crops are usually taken.

Mosaic has been observed in Hawaii since 1908. For some unexplained reason it has so far done little serious damage, and no control measures have been adopted other than care in seed selection. Considerable damage is caused by eye spot in certain districts, but none of the other major diseases are present.

H 109 is now the leading variety on all the best irrigated lands. D 1135 is largely planted at higher elevations and on non-irrigated lands, while Striped Tip is planted at the highest elevations. Yellow Caledonia, which only a few years ago was the leading kind, is being rapidly replaced by H 109. Lahaina (Otaheite) is still planted in a few localities.

As seen from the following table of production, total yields are constantly rising, but this is mainly from improved methods rather than from increased acreage:

Year	Tons	Year	Tons
1917–18	512,373	1922–23	479,463
1918–19	537,241	1923–24	626,279
1919–20	508,469	1924–25	692,804
1920–21	504,073	1925–26	705,350
1921–22	502,194	1926–27	714,000

THE CANE-SUGAR INDUSTRY IN INDIA

India produces more cane sugar than any other country except Cuba, but the condition of the industry is in striking contrast to that just discussed for Hawaii. There are a few modern factories, but the great bulk of the sugar is made in little local mills and "open-kettle" outfits, even cruder than those in the West Indies a hundred years ago. The greater part of the product is "gur," a solidified mass containing both the sugar and the molasses.

The sugar industry is widely scattered, curiously occupying a larger area in northern than in southern India.

The number of varieties planted is very great, the *Saccharum Barberi* and *Saccharum sinense* kinds predominating in the northern districts and various of noble canes in the south. The new seedlings produced at the Coimbatore breeding station are now extensively replacing the older kinds. Co 210 and Co 213 are the kinds being most planted.

Mosaic occurs, and smut is a serious disease of the native canes.

Annual production figures follow:

Year	Tons	Year	Tons
1917–18	3,311,000	1922–23	3,044,000
1918–19	2,370,000	1923–24	3,317,000
1919–20	3,049,157	1924–25	2,548,000
1920–21	2,506,320	1925–26	2,977,000
1921–22	2,532,500	1926–27	3,208,000

Notwithstanding this comparatively heavy local production, heavy annual importations are made from Java to supply the domestic demand. In 1926 680,000 tons were imported.

THE CANE-SUGAR INDUSTRY OF JAVA

The total production of sugar in Java stands third, being exceeded only by Cuba and India. In acre yields, factory methods, and general organization the industry can only be compared with that of Hawaii, the two clearly constituting a class by themselves. As between the two, it is difficult to decide which should be considered as holding first place. Their problems have been very different and they have met them differently and equally successfully.

In Java all of the cane is grown by administration, and all of it is under irrigation, no ratoon crops are taken, the cane occupying the land for from twelve to sixteen months when it must revert for the planting of food crops for at least two years before it is again planted to cane. Practically all of the work is done by hand labor. Sulphate of ammonia is usually the only fertilizer used. Average yields amounting to 6 short tons of sugar per acre for the whole island were reported for the crop of 1925. In comparing this with the 6.377-ton average reported from Hawaii it must be remembered that this is all plant cane and all grown under irrigation but it has only occupied the land for a little over twelve months instead of over eighteen months. On this basis Java is ahead of Hawaii, but she has no single record equaling the 18.09 tons per acre of Central Ewa. Considering that it is all young plant cane, yields per ton are satisfactory, averaging about 11.5 per cent in recent years.

Like Hawaii, Java has long maintained a very efficient experiment station. Its most outstanding work has been in the breeding of cane varieties, and especially in the crossing of distinct species and races in order to combine hardiness and disease-resistance with high sugar yields. The celebrated POJ canes, which have saved the industry in Argentina and are now saving it in Louisiana, were bred here.

Java has long suffered from mosaic, sereh, and leaf scald. It was the presence of these diseases that early led to the variety-breeding work. They are all successfully held in check by care in the selection and propagation of seed and by the practice of taking no ratoon crops.

Many radical changes in varieties have occurred. It was the Dark Cheribon that went down so disastrously during the sereh epidemic. Ten or twelve years ago, the bulk of the crop was being made from 247(Brucius) and POJ 100. These were gradually replaced by EK 28 and DI 52 which, by the crop of 1926–7, were making over 70 per cent of the sugar. In this year, however, a new cane POJ 2878, made 12½ per cent of the crop and its planting has increased so rapidly that it is reported that the crop of 1927–28 will be very largely of this kind.

Sugar production for ten crops:

Year	Tons	Year	Tons
1917–18	1,778,345	1922–23	1,746,875
1918–19	1,789,408	1923–24	1,771,772
1919–20	1,335,763	1924–25	1,977,490
1920–21	1,508,755	1925–26	2,278,900
1921–22	1,649,610	1926–27	1,954,957

THE CANE-SUGAR INDUSTRY OF LOUISIANA

The sugar industry of Louisiana has been passing through a severe and really very needless crisis. The seriousness of the crisis is eloquently told by the appended table of production for the past ten years. That most

of these losses could have been avoided is certain. The widespread occurrence of mosaic in Louisiana was known in 1919. All of the methods of combating it that are now known were published by the Insular Station of Porto Rico in the same year. Nothing then prevented the gradual adoption of the measures that are now being taken except the unaccountable inertia of the so-called "practical" men at the head of the industry. It is indeed unfortunate that so few men are really able to learn until they are compelled to do so by needless losses.

The Louisiana climate gives a short growing season and compels a very short period of grinding. Only early-maturing varieties can be planted, and all fertilizer applications and other cultural methods should be centered on the one point of securing early maturity.

Agricultural methods in Louisiana are in the main very good. Implement tillage of cane practically had its origin there. Fields are usually well prepared, well drained, and carefully cultivated.

The varieties formerly grown were Louisiana Purple (Dark Preanger) and Louisiana Ribbon (Striped Preanger). Later these were largely replaced by D 74 and D 95. All these are now being rapidly replaced by the mosaic-tolerant and cold-resistant Java hybrids, POJ 36, 213, and 234.

It seems certain that in the immediate future the industry will be fully restored and probably greatly increased.

Production table for ten crops follows:

Year	Tons	Year	Tons
1917–18	217,499	1922–23	263,478
1918–19	250,802	1923–24	144,664
1919–20	108,035	1924–25	79,002
1920–21	150,996	1925–26	124,447
1921–22	289,669	1926–27	42,112

THE SUGAR-CANE INDUSTRY IN MAURITIUS

This little island in the middle of the Indian Ocean has long been an important factor in sugar production. It is one of the first places where the question of cane varieties received really serious attention, and it is the gateway through which most of the older kinds reached America.

The soils are of basaltic origin, very fertile, and well drained, but in some places so rocky as to impede implement cultivation. Cane is grown both by administration and by small planters. On the large estates tractors and implement cultivation are largely used, but many of the small planters still open planting holes by hand, especially on the more rocky lands. Pen manure is generally used, but commercial fertilizers are used only on the higher lands. Four or five ratoon crops are usually taken.

The island is said to be free from mosaic, but gum disease is present and root disease is often troublesome. The worst insect pest is one of the

root grubs. White Tanna (Yellow Caledonia) is still the chief kind planted but it is losing ground. D 74 and various local seedlings are considerably planted, and D 109 and BH 10(12) are gaining in favor.

A production table follows:

Year	Tons	Year	Tons
1917–18	225,466	1922–23	231,190
1918–19	252,770	1923–24	201,550
1919–20	235,490	1924–25	224,710
1920–21	259,872	1925–26	241,220
1921–22	197,420	1926–27	196,000

THE CANE-SUGAR INDUSTRY IN MEXICO

The industry is widely scattered in Mexico. There are some mills near the Gulf coast, but the chief center is on irrigated lands near the west coast. The lands are rich, and agricultural practices fairly good, none of the major cane diseases have been reported, but in the west coast district there is very serious damage from the moth stalk borer.

Striped Mexican (Striped Preanger) is still the kind mostly cultivated.

The total ten-year production is given. It is steadily increasing:

Year	Tons	Year	Tons
1917–18	40,000	1922–23	149,388
1918–19	70,000	1923–24	166,932
1919–20	92,000	1924–25	165,223
1920–21	110,700	1925–26	190,282
1921–22	129,218	1926–27	175,000

THE CANE-SUGAR INDUSTRY IN NATAL

The South African sugar industry is largely confined to a narrow coastal strip in Natal, but it is being extended into Zululand. The greater part of the district is subtropical, but there seems to be no difficulty from freezing.

Most of the cane is grown by independent farmers. A "long crop" system is followed, the cane being cut at from eighteen to twenty-four months. A number of ratoon crops are taken.

On account of an early, severe outbreak of mosaic, Uba is practically the only kind planted. This is the only country where the entire crop is from an immune variety. That such plantings are profitable is shown by the steady rise in production.

Total yields for ten years follow:

Year	Tons	Year	Tons
1917–18	93,679	1922–23	142,287
1918–19	134,119	1923–24	181,558
1919–20	168,913	1924–25	143,974
1920–21	128,285	1925–26	214,152
1921–22	132,388	1926–27	216,305

THE CANE-SUGAR INDUSTRY IN PERU[4]

The sugar industry of Peru is confined to certain irrigated valleys near the coast. Most of the cane is grown by administration. Agricultural practices are very good indeed, including very thorough preparation, often with steam plows, and efficient tillage. On some plantations tractors are extensively used for cultivating. The "long crop" system is followed, cane usually being cut at from sixteen to twenty-four months. Numerous ratoon crops are taken, only about one-tenth of the land being replanted each year. Applications of fertilizers are given, both with plant cane and ratoons. Both Peruvian Guano and nitrate of soda are used.

Serious cane diseases are unknown. The moth stalk borer is the most serious insect pest, largely because of the universal habit of burning the fields.

This is the only country where the Otaheite is still the leading variety. Such long ratooning from this kind is certainly very remarkable.

Yields for ten years follow:

Year	Tons	Year	Tons
1917–18	287,480	1922–23	320,544
1918–19	287,028	1923–24	316,904
1919–20	313,688	1924–25	310,522
1920–21	269,010	1925–26	265,000
1921–22	319,321	1926–27	275,000

THE CANE-SUGAR INDUSTRY OF THE PHILIPPINES

The original center of the sugar industry of the Philippines was the island of Negros, but it is being rapidly extended in Luzon and other of the islands. As the islands are inside the American tariff lines and have an abundance of available land, production is increasing rapidly, having more than doubled during the past ten years.

Agricultural practices are exceedingly varied, ranging from the crudest to the most modern.

Mosaic, leaf scald, Fiji disease, and downy mildew are all present.

Formerly the principal varieties were Luzon White and Negros Purple.

[4] See Rosenfeld, Int. Sug. Jour., 1926, p. 590.

At the present time a considerable number of other kinds are being planted commercially.

A table showing total production for ten years follows:

Year	Tons	Year	Tons
1917–18	216,260	1922–23	263,437
1918–19	195,289	1923–24	372,332
1919–20	209,336	1924–25	581,064
1920–21	255,843	1925–26	436,705
1921–22	338,160	1926–27	575,000

THE CANE-SUGAR INDUSTRY IN PORTO RICO

Since this island has come under the tariff protection of the United States, its sugar industry has shown remarkable development. It has also shown the devastating effects of a widespread mosaic epidemic,[5] and the spectacular increase in production following the control of the disease and the substitution of higher-yielding varieties and better cultivation methods. The increase of these recent years has been due solely to these causes and not to increased acreages.

Agricultural practices are now fairly good, though there is still too much dependence on hand labor. Still further improvement and considerable economies would follow from more implement tillage and less hoe work. Commercial fertilizers are quite generally used. Drainage is well understood and widely practiced, but, again, at the cost of two much hand labor. From one or two up to as many as five or six ratoon crops are taken. Irrigation is widely practiced on the south coast. The rest of the island is for the most part dependent on rainfall.

Mosaic and gum disease are both present and there is considerable trouble from root disease, especially where there is lack of sufficient implement tillage. Mosaic is controlled both by eradication and by the use of tolerant and immune varieties. The former method is coming more and more into use in order to permit of the planting of high sugar-yielding varieties. Gum disease gives but little trouble with the resistant varieties now generally planted.

Before the mosaic epidemic, Rayada (Striped Preanger) and Crystalina (Light Preanger) were most planted, although the acreage of Yellow Caledonia was increasing rapidly. Following the mosaic outbreak, the immune Kavangire and some of the tolerant POJ kinds were widely planted. At one time a third of the crop was made from Kavangire (locally called Uba). Now BH 10(12) and SC 12(4) are being very widely planted.

Ten-year production figures follow:

[5] It should be remembered that less than half of the total area was ever seriously infected. Remedial measures were adopted in time to prevent full infection, such as has occurred in Louisiana.

Year	Tons	Year	Tons
1917–18	413,958	1922–23	338,456
1918–19	362,618	1923–24	399,975
1919–20	433,825	1924–25	589,760
1920–21	438,494	1925–26	541,485
1921–22	362,442	1926–27	550,000

THE CANE-SUGAR INDUSTRY OF SANTO DOMINGO

This was the birthplace of the industry in America, the first cane having been planted and the first sugar made on this island. With more settled political conditions, the industry is now increasing rapidly, production having more than doubled in the past ten years. Most of the factories are on or near the south coast, although a few of the smaller ones are on the north coast.

Agricultural practices vary from the crudest to the most modern. Irrigation is extensively used on a part of the plantations. The cane is ratooned for long periods.

Mosaic is widely prevalent. It is being more or less controlled by eradication and seed selection.

Crystalina and Rayada are being gradually superseded by BH 10(12) and Se 12(4).

A table of ten years' production follows:[6]

Year	Tons	Year	Tons
1917–18	127,322	1922–23	184,171
1918–19	158,309	1923–24	229,373
1919–20	175,736	1924–25	311,270
1920–21	185,546	1925–26	354,720
1921–22	157,143	1926–27	270,000

TOTAL WORLD PRODUCTION OF CANE SUGAR

Besides these principal centers of production, cane is grown and sugar made in a smaller way in a considerable number of other countries. This brings the total world production up to the following figures:

Year	Tons	Year	Tons
1917–18	12,365,569	1922–23	13,120,636
1918–19	11,914,457	1923–24	14,254,631
1919–20	12,235,762	1924–25	15,627,767
1920–21	11,942,390	1925–26	16,244,528
1921–22	12,707,477	1926–27	15,679,062

[6] It should be noted that there is a considerable export of cane to Porto Rico, where it is ground in Porto Rican mills. There is no duty on cane imported into American territory.

To this, for comparison we may add the

TOTAL WORLD PRODUCTION OF BEET SUGAR

Year	Tons	Year	Tons
1917–18	5,015,262	1922–23	5,202,661
1918–19	3,883,003	1923–24	5,861,478
1919–20	3,259,380	1924–25	8,093,453
1920–21	4,687,412	1925–26	8,277,281
1921–22	4,914,081	1926–27	7,672,836

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